Climate Change and Health Equity: A Research Agenda for Psychological Science

Adam R. Pearson, Ph.D., Pomona College

Kristi E. White, Ph.D., University of Minnesota

Leticia Nogueira, Ph.D., MPH, American Cancer Society

Neil A. Lewis, Jr., Ph.D., Cornell University

Dorainne J. Green, Ph.D., Indiana University

Jonathon P. Schuldt, Ph.D., Cornell University

Donald Edmondson, Ph.D., MPH, Columbia University

Post-print version 8.26.22

To appear in American Psychologist

This version is not the final copy of record and may not exactly replicate the final version. The final version will be available upon publication at DOI: 10.1037/amp0001074

Corresponding author:

Adam R. Pearson

Department of Psychological Science

Pomona College

Claremont, CA 91106

adam.pearson@pomona.edu

Abstract

Climate change poses unique and substantial threats to public health and well-being, from heat stress, flooding, and the spread of infectious disease to food and water insecurity, conflict, displacement, and direct health hazards linked to fossil fuels. These threats are especially acute for frontline communities. Addressing climate change and its unequal impacts requires psychologists to consider temporal and spatial dimensions of health, compound risks, as well as structural sources of vulnerability implicated by few other public health challenges. In this review, we consider climate change as a unique context for the study of health inequities and the roles of psychologists and health care practitioners in addressing it. We conclude by discussing the research infrastructure needed to broaden current understanding of these inequities, including new cross-disciplinary, institutional, and community partnerships, and offer six practical recommendations for advancing the psychological study of climate health equity and its societal relevance.

Keywords: Climate change, health inequities, environmental justice, risk perception, health communication

Public Significance Statement: This paper highlights an urgent need for psychologists, including researchers as well as those working in clinical care settings, to understand the role of climate change and its effects on natural and human systems as a fundamental driver of health inequities. We draw from current cross-disciplinary frameworks to explore how both psychosocial and structural processes can contribute to climate-related health inequities and offer guidelines for advancing psychological research on climate health equity and its societal applications.

Climate Change and Health Equity: A Research Agenda for Psychological Science

In an unprecedented joint editorial published in September 2021, the editors of over 200 medical journals issued a call for world leaders to take "emergency action" to limit global temperature increases to avoid "catastrophic harm to health," and urged governments to address the deep inequities climate change creates and amplifies. In October 2021, the World Health Organization similarly issued a call to center both health and social justice in international climate negotiations (WHO, 2021a). Globally, health benefits of climate mitigation are now referenced in 28% of national climate plans, up from only 10% in 2019, and 77% of governments report having initiated national health and climate change strategies (WHO, 2021b). Furthermore, and in contrast to previous assessments, issues of equity now feature prominently in the latest Intergovernmental Panel on Climate Change scientific assessment. Within the United States, regional and national policies, such as the Biden Administration's Justice40 Initiative, the Illinois Climate & Equitable Jobs Act, and New York's Climate Leadership and Community Protection Act, similarly center justice and the inclusion of frontline communities in climate decision making (Roberts, 2020)[1].

These recent efforts follow long-established scientific consensus about the threat of climate change to human and planetary health and underscore the importance of directing attention to the substantial and growing unequal threats that climate change poses to different communities around the world. Within nations, migrant, low-income, Indigenous communities, women, and communities of color are often excluded from political and economic processes and critical services that protect health and foster resilience in the face of present and future climate

[1] Frontline communities are those disproportionately impacted by climate change, such as communities targeted for marginalization (e.g. Black, Latinx), Indigenous communities, those who depend on natural resources for their livelihoods, people with disabilities or pre-existing health conditions, and economically disadvantaged and underserved communities (USGCRP, 2018).

threats (IPCC, 2022). For instance, because of historical systems of discrimination and oppression, Black, Indigenous, and other communities in the United States are often particularly vulnerable to the effects of climate change and other environmental hazards (EPA, 2021).

Although disparate health impacts of climate change were an early focus of social scientists and increasingly inform the priorities of health researchers and health care professionals, they have received remarkably limited attention to-date from psychologists (Chen et al., 1983; Nogueira et al., 2022). As a "hub" science, psychology stands to play a critical role in developing a "whole-of-science" approach to addressing climate-related health inequities. Both human drivers and societal consequences of climate change implicate human decision-making, relationships, and human systems at every level of organization, from neighborhoods to nations. As such, there is a critical need to understand how people perceive, interpret, and respond to health threats posed by climate change, both individually and collectively – processes that are the traditional domain of psychologists.

Understanding climate change can also broaden our understanding of other global health crises, and psychosocial factors that contribute to vulnerability and resilience. For instance, the COVID-19 pandemic has exposed the vulnerabilities of societies—particularly of disadvantaged communities—to global disasters, which has amplified public concern about climate change and driven new climate health messaging and policy engagement (Romanello et al., 2021).[2] Moreover, the intersection of climate change and health inequities presents new challenges and opportunities for health intervention that will require new research infrastructure, collaborations, and training initiatives. Thus, psychologists have a critical role to play in addressing the human dimensions of the climate crisis and its unequal impacts on human health.

[2] For example, in 2020, more than half of global newspaper coverage of health and climate change was linked to COVID-19 (Romanello et al., 2021).

In this review, we examine the role of climate change as a unique source and magnifier of health inequities, drawing from recent cross-disciplinary frameworks for understanding climate vulnerability and its social, structural, and geophysical determinants, and consider mediating psychological processes that may fuel and magnify health inequities[3]. We then consider the infrastructure needed to speed the development and adoption of science and community-informed solutions, including perspectives of communities often excluded from research and policymaking, and the unique role of health practitioners as change agents. We focus on the U.S. context as a case study, reflecting our primarily U.S.-based experience and expertise, but use select examples and highlight critical perspectives beyond the U.S., recognizing the inherently global nature of these issues.

Climate Change as a Context for Health Equity

Climate change exacerbates health inequities that stem from the hierarchical social systems that humans have created (Thomas et al., 2019). Economic models suggest climate change has already reduced the wealth of the world's poorest nations by 25% since 1961, disproportionately impacting food crops and labor in nations at warmer latitudes, a deficit comparable to the economic decline experienced by the U.S. during the Great Depression (Diffenbaugh & Burke, 2019). Nevertheless, a focus on economic productivity, driven by fossil fuel and other resource consumption, is also a root cause of the climate crisis, and economic losses are only one of many pathways through which climate change can create and exacerbate inequities in human health.

Globally, small island nations and Indigenous communities are among those most impacted by climate change, given their greater dependence upon the natural environment and

[3] We define health inequities as health differences that adversely affect groups of people who have experienced systematic obstacles to health based on characteristics historically linked to discrimination or exclusion.

histories of colonial exploitation resulting in loss of land, resources, and cultural identity (IPCC, 2022; United Nations, 2008). At the same time, these communities play a central role in managing earth's ecosystems, including nearly 40% of the world's protected lands, and hold local historical, ecological, and cultural knowledge that can substantially inform sustainable resource use and practices critical to safeguarding human health (Garnett et al., 2018).

Inequities also exist in access to climate adaptation and mitigation resources and decision making. For instance, within the U.S., the Federal Emergency Management Agency's (FEMA) program for voluntary buy-out of flood-prone properties is more readily available to wealthy communities (Mach et al., 2019). Similarly, measures designed to curb energy use, such as charging higher rates during periods of peak demand, put disproportionate financial strain on older adults and people with disabilities, which leads to worse health outcomes (White & Sintov, 2020). Thus, inequities can stem from discriminatory practices limiting access to adaptation resources as well as from mitigation policies designed without considering or including vulnerable populations. Inequality can also *fuel* climate change by driving more carbon-intensive and competitive modes of consumption and by concentrating political and economic power (Green & Healy, 2022). Thus, climate interventions that address existing inequities may be more effective in mitigating climate change than those that fail to take inequities into account.

Unique temporal and spatial features of climate change, and complex interactions between its physical and social drivers, present additional challenges for mobilizing coordinated responses. For instance, extreme precipitation and storm surge often co-occur along U.S. coastlines, worsening destruction in flood-prone areas and disproportionately impacting communities with less access to flood resilient infrastructure, as seen in the devastation caused by Hurricanes Katrina and Sandy (Zscheischler et al., 2018). A failure to consider these and

other physical processes may lead people to underestimate the likelihood of catastrophic compound events that disproportionately threaten frontline communities.

Climate mitigation efforts also have the potential to substantially improve community health and well-being (Lemery et al., 2021). Globally, the economic benefits of improved air quality alone with a transition to clean energy are estimated to be double the economic cost of implementing the Paris Agreement, with the largest benefits estimated for developing nations like India and China (Markandya et al., 2018). Mitigation policies that include measures to address existing inequities and improve public health, such as increasing access to affordable housing, also draw more bipartisan support than those that lack such measures (Bergquist et al., 2020). Thus, highlighting *co-benefits* of climate measures that improve health outcomes and reduce inequities can help secure public support for climate action.

A Framework for Climate Health Equity

As highlighted above, climate change forces us to consider—and develop models to better understand—unique temporal and spatial features of health equity, and to devise social and structural interventions on a scale like few other societal issues. Below, we summarize two existing and complementary conceptual models for understanding climate change as a source and magnifier of health inequities, focusing on social conditions that shape human vulnerability to climate change (i.e., *social vulnerability*; Thomas et al., 2019) and direct and indirect exposure pathways through which climate change can impact health and health inequities (i.e., *exposure pathways*; Crimmins et al., 2016). We then elaborate on and extend these models by considering broader systemic factors that drive climate health inequities within the United States and psychosocial and behavioral processes that may contribute to these inequities. Consistent with these models, we conceptualize pathways to health equity as multifaceted, encompassing

procedures or outcomes that enhance adaptive capacity (i.e., the potential to manage climate risks), reduce the burden of harmful exposures (i.e., reduced frequency or sensitivity to exposures), or enhance access to benefits of climate solutions for mental and physical health.

Social Vulnerability

Whereas early research on environmental hazards emphasized vulnerability due to the hazard itself (e.g., toxicity of a given pollutant), more recent work has focused on how underlying *social* conditions, such as structural racism, unequal access to resources, and other systemic factors determine vulnerability—the focus of environmental justice research (Mohai et al., 2009). As with other recent syntheses, we conceptualize *social vulnerability* as a dynamic state, shaped by social, economic, historical, and political factors (see Thomas et al., 2019).

Figure 1 illustrates three central features of vulnerability that can interact to shape how individuals and communities experience and respond to climate change (see Thomas et al., 2019). *Exposure* refers to conditions of the physical environment that determine the frequency and magnitude of human contact with environmental hazards, as well as direct and indirect health exposures that can create or exacerbate existing health inequities. For instance, new fossil fuel infrastructure is often sited near economically and politically marginalized communities, increasing their exposure burden relative to others (Mohai et al., 2009). *Sensitivity* refers to the degree to which a given level of exposure harms an individual or group. Globally, older populations, pregnant individuals, women, children, and those with chronic illnesses or disabilities experience greater harm from extreme weather events and resulting damage to critical infrastructure and social services than many other populations (IPCC, 2022). Similarly, due to systemic barriers fueling unequal access to critical resources, such as transportation and health

care, communities targeted for marginalization in the U.S. experience worse health outcomes from equivalent hazard exposure as other communities (EPA, 2021; Thomas et al., 2019).

Adaptive capacity refers to the ability to prepare for, cope with, or respond to climate hazards and can modulate effects of exposure and sensitivity. In the U.S., power failures have increased by 60% since 2015, due to increased frequency of extreme weather events and a reliance on centralized electricity grids, endangering populations already at elevated risk of heat exposure (Stone et al., 2021). In 2017, back-to-back category-5 hurricanes devastated Puerto Rico's power grid, leaving many of the island's older residents without access to electricity to power medical devices and keep food and medications refrigerated. However, homes with access to their own power sources or a local community solar grid were able to not only recover more quickly but also aid vulnerable neighbors, reducing inequities in health impacts (Baker, 2021). Communities subjected to economic and political marginalization may similarly experience greater vulnerability because their access to resources and services is impeded (Engle, 2011). For instance, social isolation and political marginalization of African American communities in the Chesapeake Bay reduced access to resources needed to adapt to frequent flooding, as well as representation in decision-making to aid recovery (Miller Hesed & Paolisso, 2015).

Exposure Pathways

Figure 2 illustrates multiple exposure pathways through which climate change can impact human health, drawing on findings from the US Global Change Research Program's Climate and Health Assessment – a multi-agency federal scientific initiative to assess climate impacts on human health (see Crimmins et al., 2016). These include both direct (e.g., extreme weather) and indirect (e.g., through disease vectors, healthcare disruption, unemployment) exposures, as well as secondary and tertiary impacts (e.g., on supply chains; health care delivery systems). These

impacts can be further shaped by social factors (right panel) and broader environmental and institutional factors (e.g., coastal proximity, changes to the natural and built environment; left panel) that can positively or negatively influence health outcomes and population differences in vulnerability. Less visible effects also include impacts on mental health, identity, and loss of trust and social cohesion (e.g., due to inequality or social conflict) (NASEM, 2021).

Systemic Drivers of Climate Health Inequities

Social scientific approaches have advanced understanding of the root causes of vulnerability, including systemic factors, which have been highlighted in recent cross-disciplinary and global scientific assessments (see Thomas et al., 2019; and IPCC, 2022). These include inequities in resource access; governance; and knowledge, including loss of knowledge and cultural practices of local and Indigenous communities (Thomas et al., 2019). Similarly, disinformation, a reliance on market incentives, loss of democratic processes, urbanization, and economic and political processes that facilitate these forces can also fuel and exacerbate climate-related inequities (Lamb et al., 2020).

To illustrate the role of systemic factors in shaping climate health equity, below, we highlight three interrelated systemic factors that have received growing recognition from both psychologists and health care professionals – *structural racism*, *segregation*, and *displacement* – before turning to psychological processes that may mediate effects of these and other systemic drivers of health inequities.

Structural racism and racial segregation determine access to safe and stable housing, public services, and the health of environments where Indigenous communities and other communities targeted for marginalization live, work, and play in ways that directly affect vulnerability to climate change (Bullard et al., 2011; Salas, 2021). For instance, beginning in the

1930s, the U.S. federal government established the Home Owner's Loan Corporation (HOLC) which used racial composition in its assessment of areas worthy of receiving loans. HOLC staff drew red lines (hence the term "redlining") around communities with Black and immigrant residents, flagging them as hazardous investment areas, and denied loans and insurance applications from residents in these communities, depriving them of an asset that is central to intergenerational wealth transfer, and also exposing them to a wide range of health hazards from highway development, loss of green spaces, and polluting industries (Rothstein, 2017).

Residential segregation created a platform for broad disinvestment in these neighborhoods, from infrastructure (e.g. housing, roads), services (e.g. transportation, schools), and employment opportunities, that persists today (NASEM, 2021). Together with other discriminatory policies, formerly redlined neighborhoods experience increased risk of exposure to climate hazards, with residents of those areas experiencing as much as 7C higher temperatures due to lack of tree cover –a chronic health stressor (Hoffman et al., 2020). Many Indigenous communities similarly face elevated climate vulnerability from land dispossession, compounded by racist and exclusionary policies that have impeded access to basic health and social services.

Climate change also threatens public health by driving human displacement. Extreme weather is a leading cause of forced migration globally and is projected to contribute to the internal displacement of up to 216 million people annually by 2050 (Clement et al., 2021). Notably, climate change is expected to fuel net migration *toward* rather than away from areas of higher risk, such as urban floodplains and low-lying megacities (Government Office for Science, 2011). Unlike those who migrate due to persecution or conflict, those fleeing environmental disaster often lack legal protections. Moreover, those residing in informal settlements or with

limited access to transportation or other resources are often excluded from or unable to respond to disaster warnings, further heightening their vulnerability (Thomas et al., 2019).

Due to a history of colonialism and forced displacement, many Indigenous communities around the world already experience limited access to resources, which limits adaptive capacity and increases their exposure to climate hazards. Indigenous communities have the lowest access to healthcare resources of all populations in the U.S. (Leston & Reilley, 2021), and present-day (vs. historical) tribal lands experience more drought and extreme heat events that also heighten wildfire risk (Farrell et al., 2021). Reduced transmission of Indigenous knowledge as a result of land dispossession has also threatened cultural identities and undermined adaptive capacities (Ford et al., 2020). Investing in revival and sharing of Indigenous knowledge and cultural practices, such as shared land stewardship, can bolster climate adaptation and mitigation solutions for the entire U.S. population (Ford et al., 2020).

Mediating Social and Psychological Processes

Many current cross-disciplinary syntheses neglect psychological and behavioral processes that may also contribute to climate health inequities (see Nogueira et al., 2022; and Thomas et al., 2019). Drawing from recent empirical findings and theory within psychology, below, we highlight select psychological processes that may impact vulnerability and exacerbate climate-related health inequities as illustrative examples. Following other recent equity frameworks, we also move beyond traditional dichotomies that label a given policy or practice as "(in)equitable" to consider channels through which biases can operate through any policy, social structure, or decision process to produce, maintain, or exacerbate health inequities (see Michener's [2022] Racial Equity and Policy Framework).

(Mis)Perceiving Climate Health Risks. Research documenting how information-processing limitations shape climate risk perception and decision-making has heavily informed psychological approaches to climate change (Gifford, 2011). Unique spatial and temporal features of climate change pose substantial challenges for mobilizing action to protect public health. Climate change presents both acute and chronic adaptation challenges, including "pulse" events, such as hurricanes, that quickly mobilize action, and more gradual "press" events, such as sea-level rise, that may fail to provoke a similar response (Thomas et al., 2019). Moreover, global climate change is itself a "press" phenomenon, unfolding slowly (from a perceptual standpoint) in ways that may fail to garner sufficient attention. Analyses of over 2 billion social media posts show that people adapt to temperature anomalies quickly, relying on the prior 2-8 years for comparison (Moore et al., 2019). Such rapidly shifting baselines may hinder a sense of urgency for adaptation and mitigation efforts. Tendencies to discount future versus present harms and harms to others (*temporal* and *social discounting*, respectively) can also reduce concern about climate risks and fuel inequity in resource allocation decisions (Hurlstone et al., 2020).

Many climate-related health risks are also difficult to recognize, which may further magnify health risks. Heat exposure is the leading cause of weather-related fatalities globally and disproportionately harms older adults, children, pregnant individuals, outdoor workers, and those with existing health conditions. However, heat-related illness often presents as similar to infection and other medical conditions, making it prone to misclassification (Bernstein et al., 2022; Hsu et al., 2021; Raymond et al., 2020). Similarly, air pollution from the burning of fossil fuels causes over 100,000 premature deaths annually in the U.S. alone– more than homicides and traffic accidents combined – but has traditionally received limited public attention (Goodkind et al., 2019). Although most Americans believe climate change will harm the physical health of

their communities, few foresee mental health harms, such as anxiety and depression (Kotcher et al., 2020). Understanding social and behavioral responses to "press" features of climate change and its less visible impacts remain critical avenues for psychological research and intervention.

(Mis)Perceiving Social Vulnerability. Although surveys reveal high levels of concern about effects of climate change on human health, public awareness of its *disparate* impacts in the U.S. is remarkably low. In a 2019 survey, 58% of U.S. respondents reported being "very" or "extremely" concerned about the effects of climate change on human health (AP-NORC, 2019). Yet, just 44% of young adults 18-35 surveyed in the same year reported that climate change will harm poor people more than others, and just 27% of respondents, including only 1 in 3 Black and Latino respondents, reported that climate change will disproportionately harm people of color (GenForward, 2019). Surveys of UK adults similarly find that just 26% believe that climate change will worsen existing inequalities (Framing Climate Justice, 2020).

Despite these fundamental gaps in understanding, research suggests frontline communities and non-frontline communities may fundamentally differ in how they perceive personal health risks of climate change and associated root causes. For instance, among Maryland residents, low adaptive capacity (e.g., residing in a lower-income household) increased sensitivity (e.g., residing with a person with a disability or medical condition) and increased exposure risk (e.g., residing in a floodplain) predict higher levels of climate risk perception (Akerlof et al., 2015). Similarly, residents living below the federal poverty line and those in more racially and ethnically diverse U.S. Census tracts report higher risk perceptions relative to residents of higher income and predominantly white neighborhoods, consistent with vulnerability differences across these populations (Howe et al., 2019).

Because recognition of systemic drivers of inequity has not been incorporated in the U.S. educational system, knowledge of the shared causes of environmental and other health inequities may often be gained through personal experiences. For example, U.S. Black, Latinx, women, and lower-income respondents are more likely to view social determinants of environmental risk—such as poverty, racism, and access to health care—as "environmental" issues, and these perceptions track with recognition of environmental injustice (Song et al., 2020). Moreover, 71% of Black respondents attributed disproportionate impact of Hurricane Katrina on Black communities to racial inequality, compared to 32% of White respondents (Doherty, 2015). These findings highlight the need for psychological research that can inform education and public outreach to improve public understanding of shared structural causes of climate-related and other health inequities.

Ideological Divides. Climate change has grown increasingly polarized in several major emitting nations since the 1990s, including the U.S. (Lewis et al., 2019). Nevertheless, political ideology is a weaker predictor of climate attitudes, beliefs, and policy support within many US frontline communities compared to non-frontline communities (Ballew et al., 2021; Pearson, Bacio, et al., 2021; Schuldt & Pearson, 2016). Social beliefs about inequality and individual (vs. collective) responsibility for addressing climate change can also influence how people respond to climate risks. Generally, as cultural worldviews become more individualistic and hierarchical, perceptions of environmental risks and support for pro-environmental policies diminishes (Ballew et al., 2020; Pearson et al., 2016). Existing societal inequities and motivations to maintain group hierarchies may also interact to impede mitigation. In a 25-nation study, those with a stronger preference for social hierarchies reported engaging in fewer actions to mitigate

climate change, like reducing energy consumption or boycotting high-emitting companies, and this relationship was stronger in nations with more social inequality (Milfont et al., 2018).

Intergroup Biases and Discrimination. Failing to recognize the differing perspectives of disproportionately affected populations (i.e., lack of *recognition justice*) can erode public trust necessary for collective action to address climate change (Blue & Davidson, 2020; Lewis et al., 2021). Indeed, many frontline communities, including Black, Latinx, Asian, and lower-income Americans, are misperceived as being less concerned about climate change than White and more affluent Americans (Pearson et al., 2018). Such misperceptions may perpetuate the promotion of climate mitigation and adaptation efforts that benefit White and affluent communities, limit the range of knowledge available to climate initiatives, and delay or impair the identification of new and valuable strategies for addressing climate change (Schuldt et al., 2022).

Systemic racism and segregation can also fuel biases in decision-making that contribute to environmental inequities. For instance, in a representative survey experiment, White Americans judged identical Black (vs. White) neighborhoods as more "blighted" and subsequently indicated less opposition to siting a new polluting facility near a Black neighborhood, even when presented with identical information about neighborhood property values (Bonam et al., 2016). *Colorblind ideology* – a belief in a post-racial society – poses another subtle, but no less insidious barrier to climate equity. Bugden (2022) found that whereas nearly two-thirds (59%) of U.S. adults believe that poor people experience more pollution than wealthy people, only 37% believe the same of racialized groups, despite robust evidence that race is stronger predictor of environmental exposure than poverty in the U.S. (Tessum et al., 2021). Moreover, 33% of Americans view these inequities as fair, and particularly those who express stronger racial resentment (e.g., those who oppose providing more assistance to Black

communities), which may explain why only 52% of Americans currently support direct federal funding to combat environmental racism. These findings pose a fundamental challenge for policymakers who seek to address racial (vs. economic) inequities in climate policymaking.

A Research Agenda

We currently live in unstable climatic conditions that require transformational approaches to public health. Understanding psychosocial, behavioral, and systemic drivers of climate-related health inequities is critical for protecting and improving human and planetary health; yet few models currently exist for researchers and practitioners who seek to examine and address these processes (Edmondson et al., 2022; NASEM, 2022; Nogueira et al., 2022). Below, we offer six recommendations to advance psychological research that is responsive to the complex and rapidly evolving challenges of the climate crisis and supports the needs of frontline communities. These include general recommendations to help reduce the overall climate health burden for all communities (e.g., enhancing data access and useability) as well as specific recommendations to bolster training and research capacity to support frontline communities.

Integrate Climate, Health, and Behavioral Science

Cross-disciplinary approaches have long been recognized as critical to understanding and addressing climate change and its health impacts. This includes a need for greater collaboration and data integration with the physical sciences and other social science fields that focus on inequity and power in human systems, such as sociology and human geography (see Thomas et al., 2019). Additionally, psychological perspectives on climate health equity would be greatly informed by incorporating multicultural and Indigenous perspectives and a diversified workforce. Several cross-cutting initiatives offer a blueprint for more integrative approaches. For example, the Pathfinder Initiative is currently drawing from case studies around the world to

build a global, publicly accessible collection of lessons learned from policies and practices aimed at improving human and planetary health (Haines et al., 2021; WHO, 2021b). Similar initiatives can be found with the Pacific Regional Environment Programme, a collaborative of small island nations that shares data monitoring tools to co-develop climate resilience plans, and the Rockefeller Foundation's 100 Resilient Cities initiative – a global network for developing climate resilience plans in every metropolitan city (NASEM, 2022).

Psychological scientists can use the growing public availability of climate, geography, and social vulnerability data to address threats to the mental and physical health of communities. By incorporating data from climate models and healthcare systems, for instance, we could learn how environmental changes impact psychological and behavioral outcomes that reflect inequities in health more broadly. Climate-health-behavior modeling can address basic questions that can inform health interventions, such as: How effective and generalizable are existing behavioral interventions for reducing climate-related inequities across populations?; What are the psychological and behavioral mechanisms through which climate change impacts chronic health stressors and disease progression?; and What mechanisms should researchers target to improve health outcomes in communities made particularly vulnerable to climate impacts due to systemic racism and other structural barriers to health equity?

Future research might also explore complex interactions between local climate conditions (e.g., temperature, humidity), the built environment, and their effects on behavior and mental and physical health. For instance, sleep is essential for human health and well-being; yet, since the 1980s, nights have been warming faster than days in most regions of the world, with women, older people, and those in lower-income and warmer regions disproportionately affected by heat-induced sleep loss (Minor et al., 2022). As previously noted, these effects may be exacerbated in

historically redlined communities that experience disproportionate heat exposure from excess heat-trapping pavement and lower adaptive capacity due to limited access to housing infrastructure resources (e.g., insulation, air conditioning). Moreover, thermoregulation is crucial to mitigate heat stress, but is often dysregulated in individuals with psychological disorders (e.g., anxiety; see Lõhmus, 2018). Thus, patients with psychological disorders, as well as other populations that experience inefficient thermoregulation, such as children, those with chronic health conditions, and older adults, may be particularly vulnerable to extreme heat.

Understanding how people respond to salient climate hazards is also critical to developing effective interventions to address health inequities. The premise of many behavioral interventions is that tailored health information can drive behavior change in ways that promote better health. Yet, how people actually respond to health information—and particularly information about inequities in health outcomes—is often mixed and can even be maladaptive (see Skinner-Dorkenoo et al., 2022, for a COVID-19 example). Studying the heterogeneous effects of climate health and inequity awareness will be crucial for both our science and society.

Improve Data Quality, Access, and Useability

Recent years have seen a proliferation of data tools to assess community vulnerability as well as the effects of different social and regulatory policies. For instance, The Biden Administration's new Climate and Economic Justice Screening Tool offers publicly accessible, high-resolution interactive maps to help communities across the U.S. assess their climate vulnerability and set investment priorities. Similar public-facing mapping initiatives have emerged at state and local levels, such as California's Cal-Adapt, the City of Richmond's Climate Equity Index, and New York City's Heat and Cooling Equity Initiative. Yet, few public opinion surveys currently track how residents and local officials understand these decision tools,

or their trust in the data and decision-making processes that inform them. Communities may resist efforts to identify hazard risks because of concerns about monetary impacts, such as reduced property values and higher insurance rates in flood- or wildfire-prone areas. Developing trusted and useful monitoring tools requires engaging with community members in producing, evaluating, and communicating information about climate vulnerabilities (NASEM, 2021). More fundamentally, improving data quality, access, and useability requires understanding and prioritizing the knowledge and needs of the community.

Center Frontline Communities in Climate Research and Decision-Making

Lack of diverse representation in environmental and climate science professions, as well as federal agencies that oversee U.S. climate policies has important implications for science and its societal relevance (Schuldt et al., 2022). First, the lack of diversity and centralization of power and authority within a narrow demographic restricts the universe of knowledge, critical thinking, and pool of new ideas and perspectives available for identification and implementation of climate solutions. Second, perceptions of recognition and procedural justice (e.g., being seen, valued, and treated with respect; and inclusion in decision making) are critical means through which people assess, establish, and maintain group ties (Tyler & Blader, 2003). Recognition and process fairness provide people with reassurance that a group values and represents their interests, which in turn fosters identification with a group and its goals. As Brulle (2010, p. 91) notes, “to mobilize broad-based support for social change, citizens cannot be treated as mere objects for manipulation. Rather, they should be treated as citizens involved in a mutual dialog.”

Community-based participatory research and other structured decision-making processes that integrate scientific analysis and community deliberation are one strategy that can broaden civic engagement and has seen success in climate risk management (Árvai & Gregory, 2021;

Romsdahl, 2020). These approaches help decision-makers work with community stakeholders as equal partners to identify and co-design more equitable and effective policies and programs. For instance, Phadke and colleagues (2015) recruited members of community-based organizations from four regions in St. Paul, Minnesota, representing affluent neighborhoods as well as communities often absent from city planning, such as immigrants, to contribute to the city's climate adaptation plan. Structured deliberations identified key vulnerabilities and points of agreement and disagreement in public investment priorities. Structured deliberations also have the potential to substantially reduce inequities in the transition away from fossil fuels, such as with the LA100 initiative, a partnership between U.S. National Renewable Energy Laboratory scientists and community organizations designed to ensure that the health and economic needs and priorities of frontline communities in Los Angeles drive the city's clean energy transition.

Advance and Prioritize Multicultural and Indigenous Perspectives

Researchers must also recognize the value of diverse forms of knowledge, including local and Indigenous knowledge, in developing interventions to reduce health risks and enhance mitigation, adaptation, and resilience. Multicultural and Indigenous scholarship shows that vulnerability and adaptive capacity to respond to environmental threats are both culture-bound and highly place-specific, shaped by local traditions, cultural practices, values, and beliefs. One significant mental health consequence of climate change is ecological grief associated with the loss of identity and cultural practices tied to land and the natural environment, which was first experienced by Indigenous communities targeted for their land and resources by extractive economies and is not presently captured in many contemporary environmental impact metrics (see Cunsolo & Ellis, 2018; González et al., 2022; United Nations, 2008).

Loss of Indigenous Knowledge and culture hinders the adaptive capacity of all humanity as cultural values and traditions inform a wide range of adaptation and resilience practices in many regions of the world (see Ford et al., 2020). For instance, interdependence fostered through shared labor and communal resource management among Nakanamanga of Vanuatu facilitates planning and responding to environmental hazards and disaster recovery; similarly, *war uet*, a community practice evoked during times of environmental crisis among the Guna of Central America, incorporates collective assessment and governance to identify and respond to root causes of disasters (Ford et al., 2020). Moreover, the inclusion of local and Indigenous knowledge in decision making can enhance recognition of environmental risks and promote more effective and locally tailored climate adaptation and mitigation efforts (IPCC, 2022). For instance, Indigenous fire management practices in Australia and Central and South America not only mitigate fire risks but also support biodiversity and natural carbon sinks (Ford et al., 2020). Rebuilding our social, cultural, and spiritual ties to land and water can also foster relationships with the natural environment that enhance land and water-management practices and protect human health (Ives et al., 2018). Failing to consider and prioritize local and Indigenous perspectives, thus, risks perpetuating inequities that psychologists seek to address.

Improve Public Understanding of Climate Health Inequities, Their Causes, and Solutions

Awareness of one's social vulnerability is a critical precursor to effective response preparedness (Howe et al., 2019; O'Connor et al., 1999); thus, understanding factors that shape people's perceptions of climate health risks is essential for reducing these risks. However, as previously noted, few Americans recognize unequal risks that climate change poses to different communities. This presents a fundamental challenge for advocates and practitioners who wish to advance equity-based climate initiatives.

Efforts to address inequities often begin with an assumption that facts "speak for themselves," but a growing body of research suggests these messages can produce effects opposite of those intended. For instance, White Americans show *greater* support for policies that fuel racial disparities in incarceration rates (e.g., California's three-strikes law) after learning about such disparities, in part because these messages strengthen stereotypic associations between Black people and crime (Hetey & Eberhardt, 2014). Public health campaigns that spotlight unequal vulnerabilities can have similarly mixed effects. Health messaging about reducing COVID risk improved Black and Latinx participants' knowledge about COVID transmission and preventative behavior relative to a control group but highlighting racism or economic inequality as drivers of these inequities did not (Alsan et al., 2021). Information conveying Black-White health inequities can also undermine trust in the medical community and contribute to racial inequities in receipt of preventive care (Alsan & Wanamaker, 2018; Nicholson et al., 2008).

Moreover, learning about inequities can fuel "spatial stigma" (e.g., a belief that low-income neighborhoods are dangerous) which can lead health and social service workers to avoid these areas (Keene & Padilla, 2014). At the same time, perceived inequity is a key precursor of collective action, including public support for climate mitigation policies (Pearson, Tsai, et al., 2021). These findings underscore a critical need for more psychological research on how to communicate *effectively* about inequities given growing attention to equity in climate advocacy, media, law, and public policy that we highlight at the outset of this review.

Making dangers of climate change to one's personal health salient may also stifle collective action by inducing a scarcity mindset. In experiments testing two common climate risk frames, threats to personal health or food security, Levine and Kline (2017) found that these

messages increased climate concern but *decreased* participants' willingness to personally invest in climate advocacy, relative to a control group. Health care professionals may be particularly well-positioned to develop new communications and interventions to overcome these and other psychological barriers to addressing health inequities. Health practitioners remain a trusted source of information globally, including within highly polarized nations, such as the U.S. (Kotcher et al., 2021), and polls suggest many health care professionals are interested and willing to engage in climate advocacy (Hathaway & Maibach, 2018; Maibach et al., 2021).

Expand Training Opportunities for Climate-Informed Clinical Practice and Advocacy

Psychologists who work in healthcare settings have an important role to play in addressing climate health equity, given their access to both healthcare systems and patients. Moreover, as members of teams working in clinical care settings, psychologists can help develop and incorporate health interventions that are responsive to the needs of communities and the systems that support them to mitigate climate-related mental and physical health inequities. For instance, one of the primary activities of psychologists working in healthcare settings is to improve healthcare systems, which can include advancing less carbon-intensive and more climate resilient practices within healthcare institutions (Hubbert et al., 2020). Regardless of the population being served, all psychologists working in healthcare settings are expected to meet core competencies as part of their professional practice which are also relevant and applicable to addressing climate-related health inequity. However, there is a critical need for training for psychologists working in healthcare settings that incorporate (a) foundational understanding of the relationships between climate and human health and (b) multicultural perspectives that can better address the needs and incorporate the strengths of local communities.

Psychologists working in healthcare settings can also serve as mediators to help establish community partnerships and for research, education, and public outreach, helping realize many of the research agenda goals we describe in this paper. For psychologists working in healthcare settings, training in multicultural psychology will be essential for climate health equity interventions to succeed. Much in the way it has been asserted that the open science movement would benefit from infusing cultural psychology perspectives (Syed & Kathawalla, 2022), so too would health service psychologists benefit from an infusion of multicultural perspectives into their clinical practice. Failing to do so will not only perpetuate health inequities exacerbated by climate change but also limit our collective resilience. Thus, incorporating the expertise and perspectives of communities with different cultural ties to family, community, land, and ecosystems (e.g., Indigenous perspectives) will be essential for psychologists working in health settings to use their positions effectively as climate advocates.

Conclusion

Psychology has a long tradition of studying factors that impact human health and perpetuate health inequities. In the spirit of that tradition, it is important for contemporary psychologists to consider the profound effects that climate change will have on people's health, perpetuating inequities around the globe. As we discuss in this review, climate change is a unique source and magnifier of health inequities, and psychologists are well-positioned to make crucial contributions to understanding and alleviating these inequities. Doing so will require that psychologists form new cross-disciplinary and community partnerships to better understand how psychological processes and human systems operate in tandem to shape the inequities that climate change produces and magnifies, and to identify meaningful solutions. As we do this, it is essential that knowledge is produced with communities that have often been excluded from the

research enterprise, whose lives are directly affected by research, practice, and advocacy, and whose knowledge could help advance effective and locally tailored climate and health solutions.

Understanding and alleviating these inequities will also require synergy with neighboring disciplines, including preventive medicine, epidemiology, and public health (Lemery et al., 2021). Psychology has a critical role to play in fostering a "whole-of-science" approach to addressing the climate and health inequality crisis. Psychologists have unique expertise in understanding how the mind affects, and is affected by, our physical and social environments that can complement other disciplinary efforts. These collaborations, we hope, can help to create a healthier and more just future for all.

References

Akerlof, K., Delamater, P., Boules, C., Upperman, C., & Mitchell, C. (2015). Vulnerable populations perceive their health as at risk from climate change. *International Journal of Environmental Research and Public Health*, *12*(12), 15419–15433. https://doi.org/10.3390/ijerph121214994

Alsan, M., Stanford, F. C., Banerjee, A., Breza, E., Chandrasekhar, A. G., Eichmeyer, S., Goldsmith-Pinkham, P., Ogbu-Nwobodo, L., Olken, B. A., Torres, C., Sankar, A., Vautrey, P. L., & Duflo, E. (2021). Comparison of knowledge and information-seeking behavior after general COVID-19 public health messages and messages tailored for Black and Latinx communities: A randomized controlled trial. *Annals of Internal Medicine*, *174*(4), 484–492. https://doi.org/10.7326/M20-6141

Alsan, M., & Wanamaker, M. (2018). Tuskegee and the health of Black men. *The Quarterly Journal of Economics*, *133*(1), 407–455. https://doi.org/10.1093/qje/qjx029

AP-NORC. (2019). *The August 2019 AP-NORC Center Poll*. https://apnorc.org/wp-content/uploads/2020/02/August-Omnibus-2019-topline_final-3.pdf

Árvai, J., & Gregory, R. (2021). Beyond choice architecture: A building code for structuring climate risk management decisions. *Behavioural Public Policy*, *5*(4), 556–575. https://doi.org/10.1017/bpp.2020.37

Baker, S. H. (2021). *Revolutionary power: An activist's guide to the energy transition*. Island Press.

Ballew, M. T., Pearson, A. R., Goldberg, M. H., Rosenthal, S. A., & Leiserowitz, A. (2020). Does socioeconomic status moderate the political divide on climate change? The roles of education, income, and individualism. *Global Environmental Change*, *60*, 102024.

Ballew, M. T., Pearson, A. R., Schuldt, J. P., Kotcher, J. E., Maibach, E. W., Rosenthal, S. A., & Leiserowitz, A. (2021). Is the political divide on climate change narrower for people of color? Evidence from a decade of U.S. polling. *Journal of Environmental Psychology*, *77*, 101680. https://doi.org/10.1016/j.jenvp.2021.101680

Bergquist, P., Mildenberger, M., & Stokes, L. C. (2020). Combining climate, economic, and social policy builds public support for climate action in the US. *Environmental Research Letters*, *15*(5), 054019. https://doi.org/10.1088/1748-9326/ab81c1

Bernstein, A. S., Sun, S., Weinberger, K. R., Spangler, K. R., Sheffield, P. E., & Wellenius, G. A. (2022). Warm season and emergency department visits to U.S. children's hospitals. *Environmental Health Perspectives*, *130*(1). https://doi.org/10.1289/EHP8083

Blue, G., & Davidson, D. (2020). Advancing a transformative social contract for the environmental sciences: From public engagement to justice. *Environmental Research Letters*, *15*(11), 115008. https://doi.org/10.1088/1748-9326/abbf14

Bonam, C. M., Bergsieker, H. B., & Eberhardt, J. L. (2016). Polluting Black space. *Journal of Experimental Psychology: General*, *145*(11), 1561–1582.

Brulle, R. J. (2010). From environmental campaigns to advancing the public dialog: Environmental communication for civic engagement. *Environmental Communication*, *4*(1), 82–98. https://doi.org/10.1080/17524030903522397

Bugden, D. (2022). Environmental inequality in the American mind: The problem of color-blind environmental racism. *Social Problems*. https://doi.org/doi.org/10.1093/socpro/spac005

Bullard, R., Johnson, G., & Torres, A. (2011). *Environmental health and racial equity in the United States: Building environmentally just, sustainable, and livable communities*. American Public Health Association. https://doi.org/10.2105/9780875530079

Chen, R., Boulding, E., & Schneider, S. (1983). *Social Science Research and Climate change: An Interdisciplinary Appraisal.* Springer Netherlands.

Clement, V., Rigaud, K. K., de Sherbinin, A., Jones, B., Adamo, S., Schewe, J., Sadiq, N., & Shabahat, E. (2021). *Groundswell Part 2: Acting on internal climate migration*. https://openknowledge.worldbank.org/handle/10986/36248

Crimmins, A., Balbus, J., Gamble, J. L., Beard, C. B., Bell, J. E., Dodgen, D., Eisen, R. J., Fann, N., Hawkins, M. D., Herring, S. C., Jantarasami, L., Mills, D. M., Saha, S., Sarofim, M. C., Trtanj, J., & Ziska, L. (2016). *The impacts of climate change on human health in the United States: A scientific assessment*. https://doi.org/10.7930/J0R49NQX

Cunsolo, A., & Ellis, N. (2018). Ecological grief as a mental health response to climate change-related loss. *Nature Climate* Change, 8, 275-281.

Diffenbaugh, N. S., & Burke, M. (2019). Global warming has increased global economic inequality. *Proceedings of the National Academy of Sciences*, *116*(20), 9808–9813.

Doherty, C. (2015, August 27). *Remembering Katrina: Wide racial divide over government's response*. Pew Research Center. https://www.pewresearch.org/fact-tank/2015/08/27/remembering-katrina-wide-racial-divide-over-governments-response/

Edmondson, D., Conroy, D., Romero-Canyas, R., Tanenbaum, M., & Czajkowski, S. (2022). Climate change, behavior change and health: A multidisciplinary, translational and multilevel perspective. *Translational Behavioral Medicine*, *12*(4), 503–515.

Engle, N. L. (2011). Adaptive capacity and its assessment. *Global Environmental Change*, *21*(2), 647–656. https://doi.org/10.1016/j.gloenvcha.2011.01.019

EPA (2021). *Climate Change and social vulnerability in the United States: A focus on six impacts*. https://www.epa.gov/cira/social-vulnerability-report

Farrell, J., Burow, P. B., McConnell, K., Bayham, J., Whyte, K., & Koss, G. (2021). Effects of land dispossession and forced migration on Indigenous peoples in North America. *Science*, *374*(6567). https://doi.org/10.1126/science.abe4943

Ford, J. D., King, N., Galappaththi, E. K., Pearce, T., McDowell, G., & Harper, S. L. (2020). The resilience of Indigenous peoples to environmental change. *One Earth*, *2*(6), 532–543.

Framing Climate Justice. (2020). *Research briefing: How people in the UK think about climate justice*. https://framingclimatejustice.org/resources/

Garnett, S. T., Burgess, N. D., Fa, J. E., Fernández-Llamazares, Á., Molnár, Z., Robinson, C. J., Watson, J. E. M., Zander, K. K., Austin, B., Brondizio, E. S., Collier, N. F., Duncan, T., Ellis, E., Geyle, H., Jackson, M. v., Jonas, H., Malmer, P., McGowan, B., Sivongxay, A., & Leiper, I. (2018). A spatial overview of the global importance of Indigenous lands for conservation. *Nature Sustainability 2018 1:7*, *1*(7), 369–374.

GenForward. (2019). *February survey, climate change*. https://genforwardsurvey.com/2019/05/01/climate-change/

Gifford, R. (2011). The dragons of inaction: Pychological barriers that limit climate change mitigation and adaptation. *American Psychologist*, *66*(4), 290–302. https://doi.org/10.1037/a0023566

González, R., Carvacho, H., & Jiménez-Moya, G. (2022). Psychology and Indigenous People. *Https://Doi.Org/10.1146/Annurev-Psych-012921-045304*, *73*, 431–459.

Goodkind, A. L., Tessum, C. W., Coggins, J. S., Hill, J. D., & Marshall, J. D. (2019). Fine-scale damage estimates of particulate matter air pollution reveal opportunities for location-specific mitigation of emissions. *Proceedings of the National Academy of Sciences*, *116*(18), 8775–8780. https://doi.org/10.1073/pnas.1816102116

Government Office for Science, London (2011). *Foresight: Migration and global environmental change*.

Green, F., & Healy, N. (2022). How inequality fuels climate change: The climate case for a Green New Deal. *One Earth*, *0*(0). https://doi.org/10.1016/J.ONEEAR.2022.05.005

Haines, A., Clark, H., Phumaphi, J., Whitmee, S., & Green, R. (2021). The Lancet Pathfinder Commission: Pathways to a healthy, zero-carbon future—a call for evidence. *The Lancet*, *397*(10276), 779. https://doi.org/10.1016/S0140-6736(21)00460-8

Hathaway, J., & Maibach, E. W. (2018). Health implications of climate change: A review of the literature about the perception of the public and health professionals. *Current Environmental Health Reports*, *5*(1), 197–204. https://doi.org/10.1007/S40572-018-0190-3

Hetey, R. C., & Eberhardt, J. L. (2014). Racial disparities in incarceration increase acceptance of punitive policies. *Psychological Science*, *25*(10), 1949–1954.

Hoffman, J. S., Shandas, V., & Pendleton, N. (2020). The effects of historical housing policies on resident exposure to intra-urban heat: A study of 108 US urban areas. *Climate*, *8*(1), 12. https://doi.org/10.3390/CLI8010012

Howe, P. D., Marlon, J. R., Wang, X., & Leiserowitz, A. (2019). Public perceptions of the health risks of extreme heat across US states, counties, and neighborhoods. *Proceedings of the National Academy of Sciences*, *116*(14), 6743–6748.

Hsu, A., Sheriff, G., Chakraborty, T., & Manya, D. (2021). Disproportionate exposure to urban heat island intensity across major US cities. *Nature Communications*, *12*(1), 1–11. https://doi.org/10.1038/s41467-021-22799-5

Hubbert, B., Ahmed, M., Kotcher, J., Maibach, E., & Sarfaty, M. (2020). Recruiting health professionals as sustainability advocates. *The Lancet Planetary Health*, *4*(10), e445–e446. https://doi.org/10.1016/S2542-5196(20)30225-4

Hurlstone, M. J., Price, A., Wang, S., Leviston, Z., & Walker, I. (2020). Activating the legacy motive mitigates intergenerational discounting in the climate game. *Global Environmental Change*, *60*, 102008. https://doi.org/10.1016/j.gloenvcha.2019.102008

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. www.ipcc.ch

Ives, C. D., Abson, D. J., von Wehrden, H., Dorninger, C., Klaniecki, K., & Fischer, J. (2018). Reconnecting with nature for sustainability. *Sustainability Science*, *13*(5), 1389. https://doi.org/10.1007/S11625-018-0542-9

Keene, D. E., & Padilla, M. B. (2014). Spatial stigma and health inequality. *Critical Public Health*, *24*(4), 392–404. https://doi.org/10.1080/09581596.2013.873532

Kotcher, J., Maibach, E., Miller, J., Campbell, E., Alqodmani, L., Maiero, M., & Wyns, A. (2021). Views of health professionals on climate change and health: A multinational survey study. *The Lancet Planetary Health*, *5*(5), e316–e323.

Kotcher, J., Maibach, E., Rosenthal, S., Gustafson, A., & Leiserowitz, A. (2020, June 16). *Americans increasingly understand that climate change harms human health*. Yale Program on Climate Change Communication.

Lamb, W. F., Mattioli, G., Levi, S., Roberts, J. T., Capstick, S., Creutzig, F., Minx, J. C., Müller-Hansen, F., Culhane, T., & Steinberger, J. K. (2020). Discourses of climate delay. *Global Sustainability*, *3*, e17. https://doi.org/10.1017/sus.2020.13

Lemery, J., Knowlton, K., Sorensen, C., & (Eds.). (2021). *Global climate change and human health: From science to practice* (2nd ed.). Wiley.

Leston, J., & Reilley, B. (2021). Toward a new era for the Indian Health System. *New England Journal of Medicine*, *385*(14), 1249–1251. https://doi.org/10.1056/NEJMp2108894

Levine, A. S., & Kline, R. (2017). A new approach for evaluating climate change communication. *Climatic Change*, *142*(1–2), 301–309.

Lewis, G. B., Palm, R., & Feng, B. (2019). Cross-national variation in determinants of climate change concern. *Environmental Politics*, *28*(5), 793–821. https://doi.org/10.1080/09644016.2018.1512261

Lewis, N. A., Green, D. J., Duker, A., & Onyeador, I. N. (2021). Not seeing eye to eye: Challenges to building ethnically and economically diverse environmental coalitions. *Current Opinion in Behavioral Sciences*, *42*, 60–64.

Lõhmus, M. (2018). Possible biological mechanisms linking mental health and heat—A contemplative review. *International Journal of Environmental Research and Public Health*, *15*(7). https://doi.org/10.3390/IJERPH15071515

Mach, K. J., Kraan, C. M., Hino, M., Siders, A. R., Johnston, E. M., & Field, C. B. (2019). Managed retreat through voluntary buyouts of flood-prone properties. *Science Advances*, *5*(10), eaax8995. https://doi.org/10.1126/sciadv.aax8995

Maibach, E., Frumkin, H., & Ahdoot, S. (2021). Health professionals and the climate crisis: Trusted voices, essential roles. *World Medical & Health Policy*, *13*(1), 137–145.

Markandya, A., Sampedro, J., Smith, S. J., van Dingenen, R., Pizarro-Irizar, C., Arto, I., & González-Eguino, M. (2018). Health co-benefits from air pollution and mitigation costs of the Paris Agreement: A modelling study. *The Lancet Planetary Health*, *2*(3), e126–e133.

Milfont, T. L., Bain, P. G., Kashima, Y., Corral-Verdugo, V., Pasquali, C., Johansson, L. O., Guan, Y., Gouveia, V. v., Garðarsdóttir, R. B., Doron, G., Bilewicz, M., Utsugi, A., Aragones, J. I., Steg, L., Soland, M., Park, J., Otto, S., Demarque, C., Wagner, C., … Einarsdóttir, G. (2018). On the relation between social dominance orientation and environmentalism: A 25-nation study. *Social Psychological and Personality Science*, *9*(7), 802–814. https://doi.org/10.1177/1948550617722832

Miller Hesed, C. D., & Paolisso, M. (2015). Cultural knowledge and local vulnerability in African American communities. *Nature Climate Change*, *5*(7), 683–687. https://doi.org/10.1038/nclimate2668

Minor, K., Bjerre-Nielsen, A., Svala Jonasdottir, S., Lehmann, S., & Correspondence, N. O. (2022). Rising temperatures erode human sleep globally. *One Earth*, *5*(5), 534–549.

Mohai, P., Pellow, D., & Roberts, J. T. (2009). Environmental justice. *Annual Review of Environment and Resources*, *34*(1), 405–430.

Moore, F. C., Obradovich, N., Lehner, F., & Baylis, P. (2019). Rapidly declining remarkability of temperature anomalies may obscure public perception of climate change. *Proceedings of the National Academy of Sciences*, *116*(11), 4905–4910.

NASEM (2021). Motivating local climate adaptation and strengthening resilience: Making local data trusted, useful, and used. In *Motivating Local Climate Adaptation and Strengthening Resilience*. National Academies Press. https://doi.org/10.17226/26261

NASEM (2022). *Communities, climate change, and health equity: Proceedings of a workshop in brief* (C. Berkower, A. Ulman, & A. Reich, Eds.). National Academies Press. https://doi.org/10.17226/26435

Nicholson, R. A., Kreuter, M. W., Lapka, C., Wellborn, R., Clark, E. M., Sanders-Thompson, V., Jacobsen, H. M., & Casey, C. (2008). Unintended effects of emphasizing disparities in cancer communication to African-Americans. *Cancer Epidemiology Biomarkers & Prevention*, *17*(11), 2946–2953. https://doi.org/10.1158/1055-9965.EPI-08-0101

Nogueira, L., White, K. E., Bell, B., Alegria, K. E., Bennett, G., Edmondson, D., Epel, E., Holman, E. A., Kronish, I. M., & Thayer, J. (2022). The role of behavioral medicine in addressing climate change-related health inequities. *Translational Behavioral Medicine*, *12*(4), 526–534. https://doi.org/10.1093/TBM/IBAC005

O'Connor, R. E., Bord, R. J., & Fisher, A. (1999). Risk perceptions, general environmental beliefs, and willingness to address climate change. *Risk Analysis*, *19*(3), 461–471.

Pearson, A. R., Bacio, G. A., Naiman, S., Romero-Canyas, R., & Schuldt, J. P. (2021). Cultural determinants of climate change opinion: Familism predicts climate beliefs and policy support among US Latinos. *Climatic Change*, *167*(1–2), 11.

Pearson, A. R., Schuldt, J. P., & Romero-Canyas, R. (2016). Social Climate Science: A New Vista for Psychological Science. *Perspectives on Psychological Science*, *11*(5), 632–650. https://doi.org/10.1177/1745691616639726

Pearson, A. R., Schuldt, J. P., Romero-Canyas, R., Ballew, M. T., & Larson-Konar, D. (2018). Diverse segments of the US public underestimate the environmental concerns of minority and low-income Americans. *Proceedings of the National Academy of Sciences*, *115*(49), 12429–12434. https://doi.org/10.1073/pnas.1804698115

Pearson, A. R., Tsai, C. G., & Clayton, S. (2021). Ethics, morality, and the psychology of climate justice. *Current Opinion in Psychology*, *42*, 36–42. https://doi.org/10.1016/J.COPSYC.2021.03.001

Phadke, R., Manning, C., & Burlager, S. (2015). Making it personal: Diversity and deliberation in climate adaptation planning. *Climate Risk Management*, *9*, 62–76.

Raymond, C., Matthews, T., & Horton, R. M. (2020). The emergence of heat and humidity too severe for human tolerance. *Science Advances*, *6*(19). https://doi.org/10.1126/sciadv.aaw1838

Roberts, D. (2020, July 9). *Democrats' new climate change policy platform could unite the left*. Vox. https://www.vox.com/energy-and-environment/21252892/climate-change-democrats-joe-biden-renewable-energy-unions-environmental-justice

Romanello, M., McGushin, A., di Napoli, C., Drummond, P., Hughes, N., Jamart, L., Kennard, H., Lampard, P., Solano Rodriguez, B., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Cai, W., Campbell-Lendrum, D., Capstick, S., Chambers, J., Chu, L., Ciampi, L., Dalin, C., … Hamilton, I. (2021). The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future. *The Lancet*, *398*(10311), 1619–1662.

Romsdahl, R. J. (2020). Deliberative framing: Opening up discussions for local-level public engagement on climate change. *Climatic Change*, *162*(2), 145–163. https://doi.org/10.1007/s10584-020-02754-x

Salas, R. N. (2021). Environmental racism and climate change — missed diagnoses. *New England Journal of Medicine*, *385*(11), 967–969. https://doi.org/10.1056/NEJMp2109160

Schuldt, J. P., & Pearson, A. R. (2016). The role of race and ethnicity in climate change polarization: Evidence from a U.S. national survey experiment. *Climatic Change*, *136*(3–4), 495–505. https://doi.org/10.1007/s10584-016-1631-3

Schuldt, J. P., Pearson, A. R., Neil A. Lewis, Jr., Jardina, A., & Enns, P. K. (2022). Inequality and misperceptions of group concerns threaten the integrity and societal impact of science.

The ANNALS of the American Academy of Political and Social Science, *700*(1), 195–207. https://doi.org/10.1177/00027162221086883

Skinner-Dorkenoo, A. L., Sarmal, A., Rogbeer, K. G., André, C. J., Patel, B., & Cha, L. (2022). Highlighting COVID-19 racial disparities can reduce support for safety precautions among White U.S. residents. *Social Science & Medicine*, *301*, 114951.

Song, H., Lewis, N. A., Ballew, M. T., Bravo, M., Davydova, J., Gao, H. O., Garcia, R. J., Hiltner, S., Naiman, S. M., Pearson, A. R., Romero-Canyas, R., & Schuldt, J. P. (2020). What counts as an "environmental" issue? Differences in issue conceptualization by race, ethnicity, and socioeconomic status. *Journal of Environmental Psychology*, *68*, 101404.

Stone, B., Mallen, E., Rajput, M., Gronlund, C. J., Broadbent, A. M., Krayenhoff, E. S., Augenbroe, G., O'Neill, M. S., & Georgescu, M. (2021). Compound climate and infrastructure events: How electrical grid failure alters heat wave fisk. *Environmental Science & Technology*, *55*(10), 6957–6964. https://doi.org/10.1021/ACS.EST.1C00024

Syed, M., & Kathawalla, U.-K. (2022). Cultural psychology, diversity, and representation in open science. In K. C. McLean (Ed.), *Cultural Methods in Psychology: Describing and Transforming Cultures* (pp. 427–454). Oxford University Press.

Tessum, C. W., Paolella, D. A., Chambliss, S. E., Apte, J. S., Hill, J. D., & Marshall, J. D. (2021). PM2.5 polluters disproportionately and systemically affect people of color in the United States. *Science Advances*, *7*(18), 4491–4519.

Thomas, K., Hardy, R. D., Lazrus, H., Mendez, M., Orlove, B., Rivera-Collazo, I., Roberts, J. T., Rockman, M., Warner, B. P., & Winthrop, R. (2019). Explaining differential vulnerability to climate change: A social science review. *Wiley Interdisciplinary Reviews: Climate Change*, *10*(2), e565. https://doi.org/10.1002/wcc.565

Tyler, T. R., & Blader, S. L. (2003). The group engagement model: Procedural justice, social identity, and cooperative behavior. *Personality and Social Psychology Review*, *7*(4), 349–361. https://doi.org/10.1207/S15327957PSPR0704_07

United Nations (2008). *Indigenous Peoples and climate change*. Department of Economic and Social Affairs. https://www.un.org/development/desa/indigenouspeoples/climate-change.html

USGCRP. (2018). *Impacts, risks, and adaptation in the United States: The Fourth National Climate Assessment, Volume II*. https://doi.org/10.7930/NCA4.2018

White, L. v, & Sintov, N. D. (2020). Health and financial impacts of demand-side response measures differ across sociodemographic groups. *Nature Energy*, *5*(1), 50–60. https://doi.org/10.1038/s41560-019-0507-y

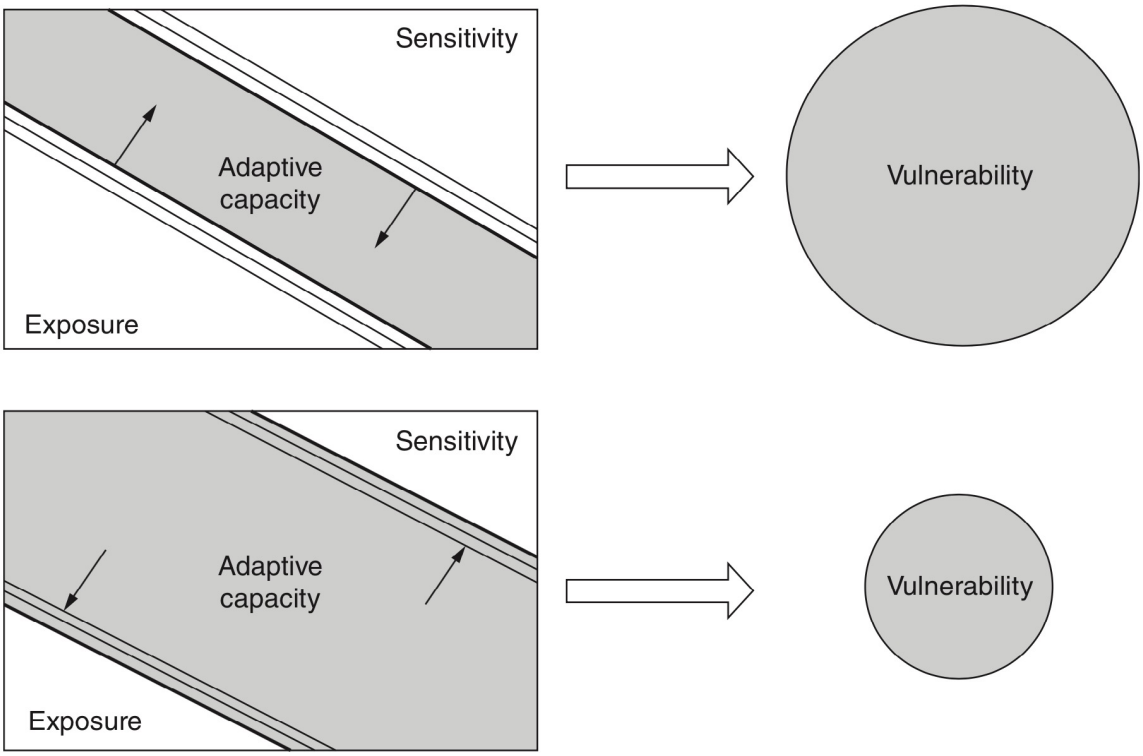
WHO (2021a). *COP26 special report on climate change and health*. https://www.who.int/publications/i/item/cop26-special-report

WHO (2021b). 2021 WHO health and climate change survey report. In *World Health Organization*. https://www.who.int/publications/i/item/9789240038509

Zscheischler, J., Westra, S., van den Hurk, B. J. J. M., Seneviratne, S. I., Ward, P. J., Pitman, A., Aghakouchak, A., Bresch, D. N., Leonard, M., Wahl, T., & Zhang, X. (2018). Future climate risk from compound events. *Nature Climate Change*, *8*(6), 469–477. https://doi.org/10.1038/s41558-018-0156-3

Figure 1

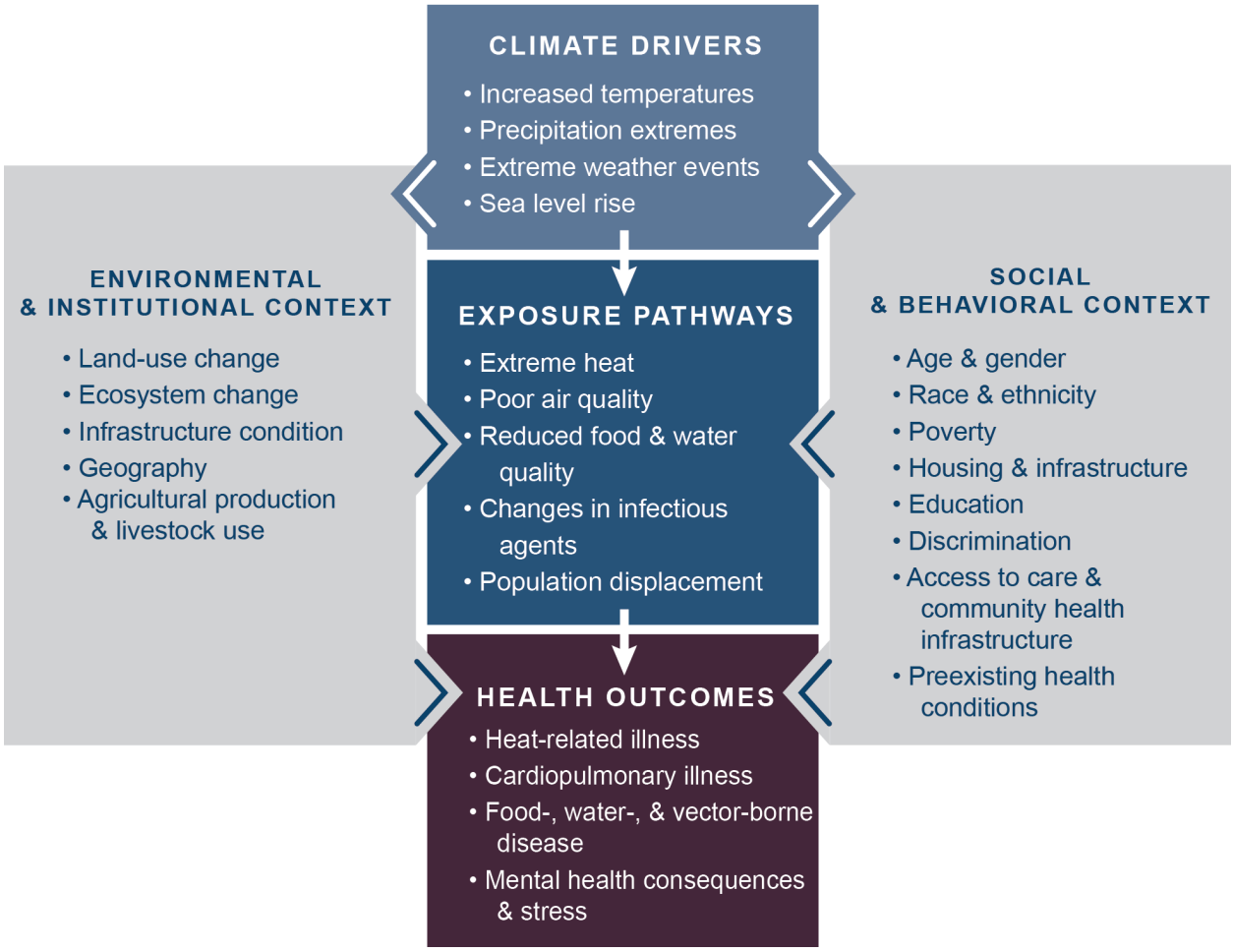
Climate Vulnerability



Note. Vulnerability reflects differences in exposure to climate-related risks, sensitivity to – or the degree to which people are affected by – those risks, and the capacity to respond to or cope with climate change across individuals or populations. Adaptive capacity modulates effects of both acute and chronic hazard exposures and sensitivity to exposures. Reprinted with permission from Thomas et al., 2019 (see also Engle, 2011).

Figure 2

Direct and Indirect Effects of Climate Change on Human Health and Well-Being



Note. Exposure pathways through which climate change impacts human health, including direct (blue) and indirect pathways through interactions with other social and structural factors that also influence health outcomes (gray). Example social determinants of health are shown on the right; factors influencing vulnerability at larger scales are shown on the left. Reprinted from Crimmins et al. (2016).