

Indigenous Health and Climate Change

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Indigenous populations have been identified as vulnerable to climate change. This framing, however, is detached from the diverse geographies of how people experience, understand, and respond to climate-related health outcomes, and overlooks nonclimatic determinants. I reviewed research on indigenous health and climate change to capture place-based dimensions of vulnerability and broader determining factors. Studies focused primarily on Australia and the Arctic, and indicated significant adaptive capacity, with active responses to climate-related health risks. However, nonclimatic stresses including poverty, land dispossession, globalization, and associated sociocultural transitions challenge this adaptability. Addressing geographic gaps in existing studies alongside greater focus on indigenous conceptualizations on and approaches to health, examination of global–local interactions shaping local vulnerability, enhanced surveillance, and an evaluation of policy support opportunities are key foci for future research. (*Am J Public Health*. 2012;102:1260–1266. doi:10.2105/AJPH.2012.300752)

The global climate is changing and will continue to change.^{1,2} Research is only beginning to examine the potential health implications and indicates significant vulnerabilities.³ Key risks include increasing exposure to infectious diseases, exacerbated water and food insecurity, natural disasters, and population displacement, detailed descriptions of which are provided elsewhere.^{3,4} Populations will be differentially vulnerable to these potential impacts at global to local levels. Those at highest risk include populations with an existing high burden of ill health, who are sensitive to climate-related health risks, and live in nations with limited technological capacity, weak institutions, high levels of poverty, and political inequality.⁵

Indigenous populations have been identified as a highly vulnerable group within global discourse on climate change because of habitation in regions undergoing rapid change, and the disproportionate burden of morbidity and mortality faced by many groups. Yet our understanding of the human dimensions of climate change for indigenous populations at a global level is limited. Ford et al.,⁶ for instance, noted how indigenous-focused content has been largely overlooked in assessment reports of the Intergovernmental Panel on Climate Change (IPCC), other major assessments,^{3,7,8} and in policy discussions surrounding the United

Nations Framework Convention on Climate Change (UNFCCC). Where indigenous issues are captured, indigenous ways of understanding and information about climate–society interactions embedded in myths, stories, tradition, and observations have typically been marginalized. This forms part of what Hulme^{9,10} and Jasanoff¹¹ described as the civic epistemology of global climate change discourse that prioritizes positivist disciplines at the expense of the interpretative, creating knowledge detached from its local context. As a consequence, indigenous peoples are often viewed as powerless victims of climate change, overlooking how social, cultural, and economic conditions determine how climate change is experienced, understood, and responded to, and downplaying the accumulated knowledge and wisdom embodied in traditional knowledge systems that can provide valuable lessons for adaptation. In this way, climate change is constructed as a problem *for* society as opposed to a problem *of* society, directing attention away from the underlying root causes of vulnerability.

In contrast to the global framing of climate change discourse for indigenous populations, there is an increasingly rich and diverse body of scholarship examining vulnerability and adaptation to climate change at a local to

regional level, with a number of studies focusing on health. Such case study research typically focuses on particular places, peoples, and cultures, but this work can also be used to identify broader trends in understanding.^{12–14} I systematically reviewed the scientific and gray literature published over the past 2 decades (1990–2010) on indigenous health and climate change to identify and characterize the systemic or systemwide determinants of vulnerability, examine the sufficiency of our knowledge base, and identify priorities for future research and current action. I identified publications through the use of multiple search engines, with inclusion and exclusion criteria designed to capture studies focusing on impacts, adaptation, and vulnerability but excluding mitigation. Full review methodology is profiled in supplementary data (available as a supplement to the online version of this article at <http://www.ajph.org>). I then used a vulnerability framework to structure the analysis of included publications, where vulnerability was conceptualized as a function of *exposure* to climate-related health risks, *sensitivity* to these risks, and *adaptive capacity* to address, plan for, or manage them^{15–17} (see supplementary data for the framework and additional analyses of key trends in publications reviewed, available as a supplement to the online version of this article at <http://www.ajph.org>).

THE STATUS AND LIMITS OF CURRENT UNDERSTANDING

Many indigenous populations face unique exposures and sensitivities to climate change, a function of close relationships with and dependence on land, sea, and natural resources; livelihoods; culture; and habitation in regions that are undergoing rapid climatic and socioeconomic change. These factors create risk profiles that differ significantly from nonindigenous populations, and also among and between indigenous groups (Figure 1).

Unique Sensitivity of Indigenous Populations to Climate Change

Understanding of the specific characteristics of climate change–related exposures and sensitivity is greatest for the Arctic and Australia (see data available as a supplement to the online version of this article at <http://www.ajph.org>). In the Arctic, many climate-related health outcomes are propagated through traditional food cultures, which have significant importance for many indigenous populations globally. There is strong empirical understanding of these links for Inuit and Alaska Natives, with sea ice change already constraining food access with implications for nutrition and cultural well-being.^{19–24} Warming temperatures have the potential to affect infectious diseases associated with the storing and preparation of traditional foods (e.g., gastroenteritis, food-borne botulism), zoonotic diseases (e.g., giardiasis),²⁵ and traditional plants or remedies.²⁶ Documented health risks facing Australia’s Aboriginal

population with climate change are quite different, associated with occupation in high-risk areas where we have a baseline understanding of how the climate is changing.^{27,28} Studies have typically examined health concerns surrounding extreme events; in particular, cyclones, flooding, and high temperature are prominent concerns.^{28–31} Other studies have identified sea-level rise and settlement viability, and infectious diseases (e.g., dengue, Murray Valley encephalitis, malaria) as the main risks affecting health.³² Two Australian studies examined the mental health dimensions of climate change,^{30,33} a topic not examined in other regions yet of key importance given links between access to traditional lands and mental well-being.^{34,35}

Sensitivity to climate-related health outcomes is also determined by the organization and structure of health systems, current burden of ill health, and material conditions and behavioral factors; that is, the social determinants of health. Herein, a number of generalizations

across regions and populations can be derived from existing scholarship.

First, traditional approaches to and conceptualizations of health remain central for many indigenous populations, based on an ideological substratum of concepts, notions, and ideas based around interpersonal and environmental relationships, stewardship, life experience and balance, spiritual considerations, family, and oral history.³⁶ The scope for climate change to affect health, therefore, is broader than altering the incidence and prevalence of disease, with potential for a range of indirect impacts, many of which will be associated with sociocultural well-being. “Western” or “allopathic” approaches are also important in contemporary indigenous health systems, and have been credited with increasing life expectancy in many regions through, for example, vaccinations and improved hygiene.^{37–39} Depending on location and historical relationships with the state, these components of the health system may exhibit

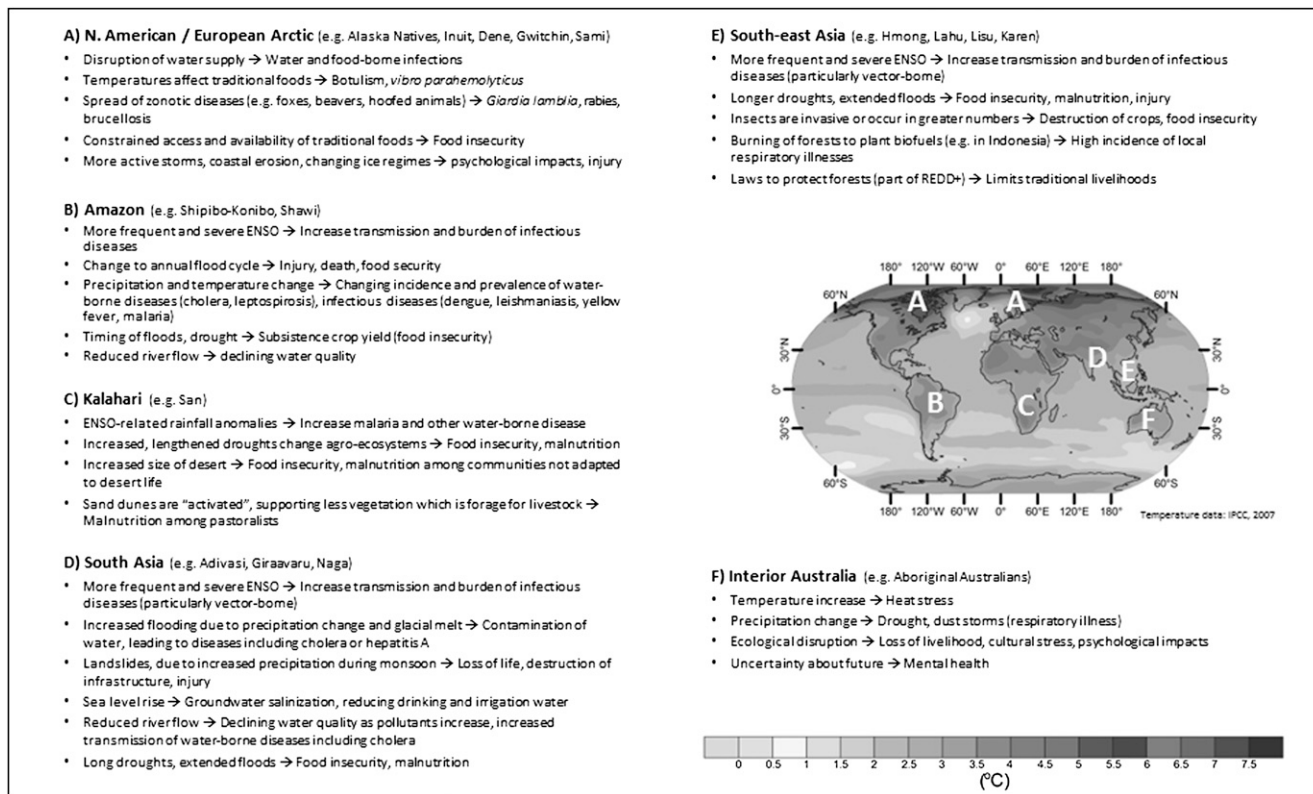


FIGURE 1—Map of projected surface temperature increase for 2090 to 2099 based on the A1B scenarios with key health risks for indigenous populations noted.

a complementary or competitive relationship. Constraints to accessing allopathic health, however, are widely noted across regions, a function of financial, geographic, and cultural barriers including a history (and current experience) of oppression through the medical system for some groups.^{37,40} These challenges have implications for informing populations about risk avoidance and prevention activities in light of a changing climate.

Second, social and economic disadvantage are evident in continuing and persistent high rates of poverty and burden of ill health for many indigenous populations, and access to education, housing, and employment are typically well below that of nonindigenous populations.³⁸ These conditions increase sensitivity to climate-related health outcomes through a number of pathways, including forcing people to live in suboptimal conditions, engage in dangerous activities, live in areas of high risk, and engage in unhealthy behaviors. For Aboriginal people in Canada and Australia, house overcrowding has been identified as increasing the risk of communicable diseases and favoring transmission of respiratory and gastrointestinal illness—health outcomes that could be affected by projected warming temperatures.^{27,41–43} Inadequate water infrastructure, common in many remote communities, increases the likelihood of outbreaks of temperature-related waterborne diseases including diarrheal disease and parasitic infections, particularly in low-income nations.^{22,27,44,45} Among Inuit populations, a high prevalence of food insecurity associated with poverty and high cost of living is expected to increase sensitivity to nutritional deficiency caused by climate change—related stresses on traditional food systems, with women and children identified to be at high risk^{22,46}; similar challenges have been identified for Alaska Native villages,^{47,48} and among Amazonian communities.⁴⁹

In poorer regions of the world, although population-specific data are lacking, it is possible to infer significant sensitivity to climate change because of pronounced health inequality among indigenous populations, which experience some of the highest rates of infant mortality, nutritional deficiency, and rates of infectious and parasitic disease globally.^{38,50} Particularly in frontier zones being affected by rapid resource development, health systems are under

significant stress associated with land expropriation, introduction of new diseases, erosion of traditional institutions, marginalization, and exposure to social and political violence.⁴ In the Amazon, for example, a resurgence of hydrocarbon-related resource development and deforestation is challenging access to and ownership of traditional lands, introducing new diseases, and creating conditions for the spread and reemergence of existing diseases, a number of which have a strong link to temperature and precipitation (e.g., dengue, malaria, leishmaniasis, cholera), with climate projections indicating more favorable future conditions.^{51–58} For Central Africa's Batwa population, insufficient resources and a heavy burden of disease are likely to create significant vulnerability to the projected health impacts of climate change.^{59–62} These challenges are likely to be elevated for Uganda's Batwa, where eviction from traditional forest lands to high-density fixed settlements with poor sanitation and limited access to water and food has increased exposure and sensitivity to climate-related health risks including malaria and parasitic infections, while violence and discrimination limit access to formal health services.^{50,63,64} Projections of increased frequency of high-intensity rainfall events could be particularly problematic, with waterborne disease outbreaks (e.g., typhoid, bacillary dysentery, *Escherichia coli*, and cryptosporidiosis) typically following heavy rainfall events and associated with fecal matter being washed into local water sources.^{65–67}

Significant Adaptive Capacity of Indigenous Populations

The literature indicates that existing sensitivities will result in climate change impacts occurring faster and of greater magnitude for many indigenous populations. Yet indigenous populations may also have significant adaptive capacity. Empirical work, mostly conducted in the Arctic, describes adaptations currently being employed to cope with a rapidly changing environment with a strong focus on food systems and dangers of engaging in harvesting activities. Adaptations are underpinned by traditional knowledge of lands and resources, cultural identity, and strong social and kinship networks, within health systems that combine allopathic and traditional approaches.^{19–22,24,68} This adaptive capacity is critical for managing

the risks of climate change. A number of studies also describe community-based initiatives to raise awareness of climate change impacts and using research to empower communities, and there are examples in the Arctic of the development of surveillance infrastructure for climate-related health outcomes.⁶⁹ Few studies, however, have examined how non-Arctic groups are responding to the health effects of climate change, and how economic resources, institutions, technology, equity, and information and skills affect this ability.

There is concern expressed in the literature that social, economic, and political transformations—rooted in colonial history, assimilationist policies, and accelerated by globalization—are having implications, many negative, for indigenous populations and their adaptive capacity. Poverty, marginalization, and lack of legal land title are all important contextual factors that affect adaptation and will be key challenges in the future. In Alaska and northern Canada, transformations of identity and community have resulted in loss of control, cultural continuity, and a weakening of traditional knowledge systems and social capital. Notwithstanding these historical conditions, significant progress has been made in developed nations in settling land claims and recognizing indigenous title, national governments have apologized for the colonial practices of history (e.g., Canada, Australia), and devolution of power to indigenous institutions has occurred in some jurisdictions. These developments hold promise for addressing some of the broader determinants of socioeconomic and health inequality that lie at the heart of indigenous vulnerability to climate change.

Poorer nations face more substantial challenges. Particularly in remote regions experiencing significant resource development pressure, indigenous integration into the global economy is occurring often with limited respect for local autonomy, and accompanied by social and political violence. Associated acculturation challenges have been linked to problems of addiction, suicide, and a weakening of social networks and traditional knowledge systems that play an important role in indigenous health systems and contribute to significant adaptive capacity.³³ The process of change and how groups experience and respond to outside stresses, however, is dynamic, and one in which

indigenous peoples are actively making, re-making, and challenging their circumstances, with varying degrees of success. Inevitably there will be winners and losers, with concern expressed that climate change could exacerbate existing inequalities at community, regional, and national levels.²² In the Peruvian Amazon, for example, Hofmeijer⁴⁹ describes how socioeconomic changes linked to resource development and improved transportation have enhanced access to regional health centers and monetary resources important for adaptation, but have also undermined traditional knowledge systems. Similarly, working with the Tsiname peoples of the Bolivian Amazon, Reyes-García et al.⁷⁰ documented increasing access to the market economy leading to a loss of knowledge of folk plant use. The potential health implications of an erosion of traditional knowledge systems in the context of climate change have not been examined outside an Arctic or Australian context, although the loss of response diversity and flexibility embodied in such knowledge systems has relevance for the management, response to, and avoidance of climate-related health risks that are projected to become more problematic in the future.

Gaps in Understanding

Existing scholarship develops a baseline understanding of the characteristics and determinants of vulnerability to the health effects of climate change for indigenous populations in a number of high-income nations, but there are significant geographic disparities. It is estimated that there are approximately 370 million indigenous people globally and at least 5000 distinct groups, with only a small fraction explicitly studied with regard to the health impacts of climate change. We know the least about regions with the largest indigenous populations, including Africa, Asia, and Latin America. It is likely that vulnerability will be high on account of a high burden of ill health, marginalization, and current exposure to climate-related health risks. Population-specific understanding on the nature of vulnerabilities and determinants remains unknown, however, and compromises our ability to safeguard the health of the most vulnerable.⁷¹ In particular, adaptation financing provided through the UNFCCC—the United Nations convention that provides a global architecture for responding

to climate change—depends upon the identification of urgent and immediate priorities for intervention: information that is generally lacking for indigenous peoples' health. This deficit is also evident in completed National Adaptation Programs of Action assessments conducted in the least developed countries and funded by the UNFCCC to identify urgent and immediate needs of the poorest nations to adapt to climate change. As of March 2011, 45 of 49 National Adaptation Programs of Action assessments had been submitted, with explicit reference to indigenous populations made in 5 (data available as a supplement to the online version of this article at <http://www.ajph.org>). In these cases, assessments note the potential for heightened vulnerability among indigenous populations, and identify importance of traditional knowledge for adaptation, but do not focus on health or identify specific concerns or needs for indigenous populations in light of a changing climate.

Although there is a strong bias toward high-income nations in the literature, there are also widespread disparities within and between these nations. In Canada, only 2 indigenous populations are studied, there is no reporting from Scandinavia or Russia, and only 1 paper reports from the conterminous United States. Disparities are also reflected in the nature of studies conducted, with the majority of empirical and adaptation research taking place in the Arctic and reflective of strong climate change signal evident in this region. Few studies have focused on differential vulnerability at a community level or examined high-risk groups (e.g., elderly, children) and research has largely been conducted in remote regions where indigenous peoples are often disadvantaged greatest but where links to traditional livelihoods and activities are strongest.

A ROADMAP FOR FUTURE RESEARCH AND ACTION

There is an emerging scholarship focusing on indigenous health and climate change, but there is a lot that we do not know. This deficit in understanding is not commensurate with the risks posed by climate change to indigenous health. Insights for indigenous populations can be derived from regional and global studies focusing on nonindigenous populations, but

generalizing is problematic for indigenous groups where scholarship indicates that impacts, adaptation, and vulnerability are highly place- and culture-specific, and mediated by worldviews that place significant value on interpersonal and environmental relationships, stewardship, life experience and balance, spiritual considerations, family, tradition, and oral history.⁶ I outline a roadmap to guide future research and identify how decision makers at various levels can use existing knowledge.

A Global Workplan

Addressing the indigenous health deficit requires a global workplan that develops a sustained process to mobilize resources for research and combines leadership by national and international bodies. Without such a workplan, indigenous health in a changing climate will continue to be neglected. Although the World Health Organization and United Nations Permanent Forum on Indigenous Peoples have noted the special needs of indigenous populations, and a number of initiatives have brought together indigenous peoples and organizations to assert their rights in a changing climate,^{72,73} the importance and need for studies on indigenous health and climate change is not currently reflected in research agendas articulated in the scientific literature or through international bodies.

From a research and policy standpoint, we need to know how global processes interact with local conditions to create vulnerable (or adaptable) populations in light of a rapidly changing climate, where indigenous people are at greatest risk, what characteristics of a population make them vulnerable or adaptable, and what health risks are most pressing. For those regions and populations where the research need is particularly acute, there is an opportunity to build upon existing information on indigenous livelihoods and the determinants of health to identify and characterize the broad-scale factors likely to affect vulnerability to climate change. Such review-based studies are useful for locating populations or regions where targeted research is required and identifying broader structural conditions that will shape vulnerability,^{14,41,74,75} and offer a low-cost, rapid entry point for initial research. How these broader factors affect vulnerability at lower scales, however, will not be uniform,

depending on location-specific socioeconomic and biophysical factors, and varying at a regional, community, and intracommunity level. This diversity in how climate change will play out locally reinforces the importance of place-based and population-specific studies.^{12,22,41,76}

In identifying research priorities, it is important to begin discussions with indigenous peoples and their organizations, with priorities likely to differ by region and population. The following are key components of a roadmap for future research:

1. *Indigenous conceptualizations on and approaches to health* need to be articulated and central to research if we are to focus on relevant health risks and capture the complex, culturally mediated interaction among social, biophysical, and biomedical determinants of vulnerability. In working with communities, it is imperative to recognize the broader structural and colonial factors shaping vulnerability, alternative worldviews, and group-specific conceptualization of health and healthy living. Failure to do so will limit our understanding of vulnerability and likely reduce the effectiveness of policy intervention.^{10,11,77,78}
2. The *collection of baseline data* on socioeconomic and biomedical determinants of vulnerability is important. For indigenous populations, we know very little about the incidence and prevalence of most infectious diseases, waterborne illnesses, and food and water insecurity.^{37,50,79} There is a need to develop an understanding of the sensitivity of health outcomes to climate, including the identification of indicators to measure and monitor, drawing upon both traditional and scientific knowledge.^{22,80} Data on the social determinants of health are often lacking, including demographics, governance, resource availability, infrastructure, and a host of other factors that influence vulnerability.
3. There is a need to *develop and improve surveillance and environmental monitoring* systems (e.g., climate data, vector distributions) that systematically collect information on health outcomes and determinants relevant to indigenous populations and that are necessary to determine the occurrence and spread of health risks.⁸¹ Existing surveillance

systems provide some coverage, particularly in developed nations, although limitations have been highlighted. New research initiatives should work with indigenous populations to collect information on climate-related health outcomes using this information for future modeling in light of projected climatic conditions where feasible, and also tap the considerable knowledge indigenous populations have in this regard. Building capacity at a local level to support surveillance activity and integrate local needs is essential.²²

4. It is imperative that studies combine fundamental scientific research with *an evaluation of opportunities for policy intervention*. Proven interventions exist for many climate-related health risks and traditional approaches to health offer a foundation for promoting health and well-being. With recognition of this, a comprehensive evaluation of adaptation needs to examine the effectiveness, desirability, and feasibility of adaptations; assess urgency; evaluate durability of adaptations under different climate and socioeconomic scenarios; and assess equity considerations^{82,83} working closely with indigenous peoples to this end.
5. *Interdisciplinary approaches* to research are required, involving collaborations across the health, natural, and social sciences, and the active engagement of indigenous communities and organizations, health professionals, and policymakers in cooperatively planning, developing, and conducting research. In particular, the humanities and interpretative social sciences have an essential role to play alongside biomedical science in examining the risks posed by climate change to health, and for too long have been neglected in mainstream health and climate change research.¹⁰ Thus, indigenous myths and stories, oral tradition, and observations hold valuable information about climate–society interactions, climate-related health risks, and current and future vulnerability and adaptation determinants.^{6,18,24,43}

Many of these research needs have been articulated in the general health and climate change scholarship, and at a global level are captured in the World Health Organization's Climate Change and Health Work Plan.⁸⁴ They are even more pertinent in an indigenous context, and offer a means of

generating important baseline information on current health risks alongside potential vulnerabilities to climate change.

What We Can Do With Existing Knowledge

This roadmap for future research recognizes that our current understanding is insufficient and likely to constrain adaptation. Yet this should not be used to justify inaction, and a number of emerging themes from this analysis identify potential entry points for health adaptation. Changing traditional knowledge systems, for example, have been identified as a key driver increasing vulnerability to climate-related health risks in numerous contexts. Efforts to preserve, document, and promote and teach traditional knowledge among younger generations, and strengthen links to traditional activities, offer key adaptation interventions. Addressing socioeconomic and health inequalities between indigenous and nonindigenous populations, securing land tenure, confronting colonial history and current reality, and community empowerment are consistently identified as essential for addressing existing health challenges, which in turn will increase resilience to climate change. These examples of entry points have widespread relevance and, though important for adaptation, also concern ongoing policy initiatives and needs in areas of social, cultural, economic, and health development. Climate change provides additional rationale for these interventions, and is consistent with scholarship that has argued that “mainstreaming” or “normalization” of adaptation is likely to be the most effective means of reducing vulnerability.^{85–88}

A CRITICAL TIME

The international policy architecture for addressing climate change through the UNFCCC is at a critical juncture as signatories debate what will replace the Kyoto Protocol when its implementation period ends in 2012. Reducing greenhouse gas emissions is essential if we are to avoid “runaway” climate change and the crossing of key climate system thresholds.^{1,3,89} The health impacts of such change would be significant and for some indigenous populations would inevitably result in the loss of homeland, livelihoods, and culture.

Adaptation will also be necessary given that we are most likely locked into at least 2 °C of warming globally this century,^{1,90} with climate change already affecting indigenous health. As part of the Copenhagen (2009) and Cancun (2010) Conference of the Parties meetings to the UNFCCC, industrialized nations pledged to provide \$100 billion per year by 2020 to help poorer nations adapt, with an interim target of \$30 billion by 2012. Whether the promised funds will materialize, or be additional to overseas development assistance, remains to be seen,^{91,92} but, regardless, adaptation is increasingly being viewed as a cornerstone of climate policy at international to local levels. For indigenous populations, adaptation offers an opportunity to strengthen livelihoods, culture, and health in the face of multiple stresses, and to (re)assert (inter)nationally recognized “special rights.” To seize this opportunity, however, requires significant effort by indigenous organizations and leaders, political actors, nongovernmental organizations, and the scientific community, to identify and justify what adaptations and support are needed. Public health research—working closely with indigenous populations and organizations—has an important role herein, providing an evidence base of the risks posed by climate change, and determinants of vulnerability and adaptability, and needs a more prominent role in future research activities. ■

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