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Collective Violence Caused by Climate Change and How It Threatens Health and Human Rights

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Abstract

The weight of scientific evidence indicates that climate change is causally associated with collective violence. This evidence arises from individual studies over wide ranges of time and geographic location, and from two extensive meta-analyses. Complex pathways that underlie this association are not fully understood; however, increased ambient temperatures and extremes of rainfall, with their resultant adverse impacts on the environment and risk factors for violence, appear to play key roles. Collective violence due to climate change poses serious threats to health and human rights, including by causing morbidity and mortality directly and also indirectly by damage to the health-supporting infrastructure of society, forcing people to migrate from their homes and communities, damaging the environment, and diverting human and financial resources. This paper also briefly addresses issues for future research on the relationship between climate change and collective violence, the prevention of collective violence due to climate change, and States' obligations to protect human rights, to prevent collective violence, and to promote and support measures to mitigate and adapt to climate change.

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Introduction

Climate change causes or contributes to adverse environmental consequences, including global warming, extreme deviations in rainfall, sea level rise, extreme weather events, and droughts, floods, and wildfires. Climate change threatens human health and well-being by increasing the risk of heat-related disorders; respiratory and allergic disorders; vectorborne, waterborne, and foodborne infectious diseases; food insecurity and malnutrition; mental disorders; and violence, most notably, collective violence.

Collective violence due to climate change threatens basic human rights, as embodied in the Universal Declaration of Human Rights (UDHR) and other international human rights instruments. For example, it threatens the rights enumerated in Article 25 of the UDHR, including the right to a standard of living adequate for health and well-being, including rights to food, clothing, housing, medical care, and social services, as well as the right to security.[1]

In this paper, we review the evidence that climate change causes or contributes to collective violence and the threats that this violence poses to health and human rights. In addition, we discuss challenges for future research on this subject, prevention of collective violence due to climate change, and States' obligations to prevent collective violence and protect human rights that are threatened by collective violence due to climate change.

Violence has long been recognized as a major public health problem.[2] It is defined as "the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment or deprivation."[3] It includes self-inflicted, interpersonal, and collective violence.

Collective violence is defined as "the instrumental use of violence by people who identify themselves as members of a group...against another group or set of individuals, in order to achieve political, economic or social objectives."[4] It includes armed conflict, state-sponsored violence (such as genocide and torture), and organized violent crime (such as gang warfare). Collective violence causes much morbidity and mortality, damage to the health-supporting infrastructure of society, forced migration, environmental damage, diversion of resources, and more violence.[5]

We next review research on the association between climate change and violence, starting with historical studies, followed by research in the modern era.

Historical studies on climate change and violence

Climate change has been associated with violence for centuries. Three studies by Zhang and colleagues provide strong evidence to support this association. Zhang et al. demonstrated that, in the Preindustrial Era (from 1500 to 1800) in the Northern Hemisphere, climate change was the major driver of armed conflict and other large-scale humanitarian crises, and that social mechanisms failed to prevent these crises.[6] The study found that falling ambient temperatures decreased agricultural production, which, in turn, led to war and other major social problems, including inflation, famine, and population decline.[6] In another study, Zhang et al. found that, in preindustrial Europe, cooling of the climate between 1560 and 1660 was the ultimate cause of successive agro-ecological, socioeconomic, and demographic catastrophes.[7] In yet another study, Zhang et al. found that the frequency of warfare in eastern China over the past millennium was significantly associated with Northern Hemisphere temperature oscillations, especially cooling phases that significantly decreased agricultural production.[8]

Tol and Wagner studied the relationship between temperature and precipitation in Europe and the

occurrence of violent conflict over a millennium. They concluded that conflict was more intense when the climate was colder. However, they found that this association weakened in the Industrial Era and predicted that global warming would not likely increase violent conflict in temperate climates.[9]

Modern-era research on climate change and violence

Influence of temperature on violence

Hsiang et al. found that, in the tropics from 1950 to 2004, the probability of new civil conflicts doubled, from 3% to 6%, during El Niño years (when much of the continental tropics becomes substantially warmer and drier). Although they found that in more temperate latitudes changes were usually less extreme, they concluded that the El Niño/Southern Oscillation may have influenced the development of 21% of civil conflicts since 1950.[10]

Burke et al. found, in sub-Saharan Africa between 1981 and 2002, a strong association between warmer temperature and civil war. They predicted a 54% increase in armed conflict in Africa by 2030, with 393,000 battle-related deaths.[11] Although Buhaug has noted that during the past 30 years temperature has risen in most of Africa but the incidence of civil war has decreased, we believe that the Burke et al. study provides relevant credible data.[12]

O'Loughlin et al. found, in East Africa between 1990 and 2009, that temperatures much warmer than normal increase the risk of violence. Although this relationship was statistically significant, they noted that warmer temperature was only a modest predictor of violence compared to political, economic, and physical geographic predictors.[13]

Maystadt et al. found, in Somalia between 1997 and 2009, that drought fueled conflict through shocks in the price of livestock. They predicted that, if the average temperature in East Africa rose approximately 3.2°C by 2100, cattle prices would fall about 4% and violent conflict would increase by about 58%.[14]

Influence of rainfall on violence

Several studies have found that a substantial decrease in rainfall and associated drought results in increased conflict. Levy et al. found that, when rainfall was significantly decreased, there was a significantly increased probability of internal conflict starting in the following year.[15] Fjelde and von Uexkull found, in sub-Saharan Africa between 1990 and 2008, that large decreases in rainfall from historic norms were associated with increased risk of communal conflict.[16] Harari and La Ferrara found, in Africa between 1997 and 2011, that negative climate shocks during the growing seasons of main crops had a sizeable and persistent impact on increasing the incidence of conflict at the sub-national level, especially violence against civilians; they predicted that severe climate shocks during growing seasons would become 2.5 times as frequent during the next two decades, leading, in turn, to a 7% rise in the average incidence of conflict.[17] Sarsons found, in India from 1970 to 1995, that marked decreases in rainfall were associated with conflict and that excessive rainfall decreased the likelihood of conflict by almost 8%.[18]

To the extent that climate change leads to decreased rainfall, it will further worsen freshwater shortages, especially in water-stressed countries in the Middle East, North Africa, and South Asia. These shortages are already being worsened by high population growth rates, rapid urbanization, industrialization, and modernization. There is much evidence that water shortages increase conflict. Since 1960, intrastate and interstate conflicts over water have been increasing substantially, with more than two-thirds of them occurring in the context of violence—although generally low-level violence.[19] Between 1960 and 1989, there were 38 water-related conflicts globally (1.27 annually); between 1990 and 2007, in contrast, there were 83 (4.61 annually).[20]

The spark that started the civil war in Syria may have been related to climate change. A drought there between 2006 and 2010 transformed almost 60% of the country into desert and, by 2009, may have killed as much as 80% of cattle. Hundreds of thousands of farmers migrated to cities, seeking

work, and many felt they were mistreated by the government. The dislocation and difficult conditions of the farmers helped to create the first spark of the civil war.[21]

Similarly, in Mali, during the past 20 years, drought periods have occurred more frequently, placing greater stress on a vulnerable population and fragile environment in a country with weak political institutions as well as religious and ethnic tensions. In early 2012, rebels in northern Mali began an anti-government uprising, which led to a declaration of an independent Islamic state that was eventually overtaken by French and West African military forces.[21]

Conflicts related to climate change do not necessarily have adverse outcomes. Johnstone and Mazo assert that climate change may have hastened the birth of the Arab Spring. They suggest that climate change might increase the likelihood of similar events occurring elsewhere.[22]

Some studies have not found an association between conflict and decreased rainfall and/or drought. For example, Theisen et al. found, in Africa between 1960 and 2004, no direct association between drought and civil war, and concluded that the main causes of intrastate armed conflict are political.[23] Theisen found, in Kenya from 1989 to 2004, that years with below-average rainfall tended to have a peaceful effect on the following year and that election years had more violence.[24] Adano et al. concluded that climate change does not explain violent conflict in pastoral areas in Kenya.[25] Opiyo et al. concluded that violent conflicts in pastoral areas in drought-prone northwestern Kenya result from a complex interaction of sociocultural, economic, and political factors.[26] Benjaminsen et al. found, in the Sahel in West Africa, that factors other than those directly related to the environment and resource scarcity, such as government corruption and obstructed mobility of livestock and herders, represent the most plausible explanations for violent conflict.[27] Buhaug concluded that climate variability is a poor predictor of armed conflict and that civil war in Africa is best explained by ethno-political exclusion, poor national economies, and the collapse of the Cold War system.[28]

Some studies have found that *increased* rainfall can be associated with violence. For example, Salehyan and Hendrix found that, globally between 1979 and 2006, *abundance* of water correlated with political violence.[29] Hendrix and Salehyan found, in sub-Saharan Africa between 1991 and 2007, that rainfall was associated with civil war and insurgency, and extreme deviations in rainfall—especially abundant rainfall—were strongly associated with violent events.[30]

Meta-analyses of studies on climate change and violence

Meta-analyses of numerous studies provide the strongest evidence of a causal link between climate change and violence. The most comprehensive investigation on climate change and human conflict has been a meta-analysis by Hsiang et al., which was based on 60 longitudinal studies, mostly published since early 2009.[31] They found that deviations from normal precipitation and from mild temperatures significantly increased the risk of conflict, especially in poorer populations. They estimated that each standard deviation in climate toward more rainfall or warmer temperatures (equivalent to about a 3°C rise above average in New York City temperatures) increased the frequency of intergroup conflict overall by 14%—and in some places by more than 50%. They appropriately concluded that, with rising temperatures over future decades, there could be substantial increases in conflict.[31] Although critics have suggested that this meta-analysis suffers from selection bias and conflates climate with weather, we believe that the authors have adequately refuted critiques concerning selection bias and that their inclusion of papers that cover long time periods minimizes the concern about conflating climate with weather.[32,33] We therefore find its results and conclusions to be compelling evidence of a causal association between climate change and violent conflict.

Another meta-analysis and review by Hsiang and Burke, in which they examined 50 quantitative studies for the relationship of climatological variables on violent conflict and sociopolitical instability, led to similar conclusions.[34] They demonstrated that, when temperatures are hot and precipitation

is extreme, both conflict and sociopolitical instability increase. They found that studies that were best designed to determine causation overwhelmingly found strong associations between climatic anomalies and conflict/social instability, and that climatic events influence many different types of conflict on a wide range of spatial scales.[34]

Influence of sea level rise on violence

It is predicted that by 2100, sea level will rise 0.5 to 1.4 meters (about 20 to 55 inches) above the 1990 level.[35] How much sea level will *actually* rise is dependent on the degree of global warming, the amount of ice melting in polar regions (not sea ice melting), and other factors.

Sea level rise will have its greatest impact on people living in coastal areas, where one-fifth of the world's population resides. This impact will be most profound on people living in island nations and in densely populated coastal areas of countries like Bangladesh. Some of these island nations may disappear and some coastal regions may become uninhabitable, forcing many people to become "climate refugees," migrating within their own countries or to neighboring countries. In addition, sea level rise will likely increase saltwater incursion into river deltas and coastal groundwater aquifers, damaging cropland, causing food and water shortages, and forcing people to migrate. These displacements are likely to cause social, economic, and political upheavals associated with violence as individuals and groups compete for control of land and other resources.

A wide range of assessments and predictions have been made on the number of climate refugees. In 2009, the chief of UNHCR: The UN Refugee Agency stated that in 2008 more than 20 million people had been forced to move due to factors related to climate change, mainly storms and floods.[36] We believe that it is extremely difficult to predict how many climate refugees there will be in the future. Some commentators have criticized the quest to develop and to label people as "climate refugees," noting that this could lead to inappropriate global management of this problem.[37]

Collective violence due to climate change threatens health and human rights

Collective violence due to climate change poses multiple serious threats to health and human rights. The UN and other international bodies have recognized the broad impact of climate change on human rights.[38]

As with collective violence due to other causes, collective violence due to climate change causes morbidity and mortality that mainly affects non-combatant civilians. This impact on non-combatant civilians is in violation of international human rights law intended to protect them during armed conflict and in violation of the right to security embodied in the UDHR and other international human rights documents.[39]

Most of the morbidity and mortality associated with collective violence results from breakdown of the health-supporting infrastructure of society. This breakdown, by limiting access to food, water and sanitation, and medical care and public health services, contributes to illness and death. It also leads to violation of basic human rights—such as the rights to food, water and sanitation, and medical care—that are embodied in the UDHR and other international human rights instruments.[39]

Climate change causes forced migration, not only by collective violence, but also by sea level rise, droughts, flooding, and extreme weather events. When people are forced to leave their homes and communities, their health and many of their human rights are threatened, including their rights to housing and security. Compared to refugees (who receive asylum in other countries), forced migrants who are internally displaced within their own countries face even greater threats to their health and human rights since they are less likely to have access to food, water and sanitation, and medical care.[40]

Similarly, climate change causes and contributes to damage to the environment, not only by collective violence, but also by sea level rise, droughts, flooding, and extreme weather events.

Sea level rise, droughts, and flooding often cause damage to croplands, leading to decreased agricultural yields, with resultant threats to human rights

(the right to food and the right to health) and to health (leading to malnutrition and increased associated risks of morbidity and mortality due to infectious diseases).

Finally, collective violence diverts human and financial resources to armed conflict and away from essential human services that support health and assure human rights.

In sum, climate change and collective violence represent serious threats to public health—defined by the Institute of Medicine as "what we, as a society, collectively do to assure the conditions in which people can be healthy."[41]

Discussion

In this section, we discuss three of the many sets of issues related to this paper: research findings and issues, prevention of collective violence related to climate change, and States' obligations to prevent collective violence and protect their residents' human rights that are threatened by collective violence due to climate change.

Research findings and issues

As presented in this paper, the weight of evidence demonstrates that climate change causes and contributes to collective violence, based on studies in widely varying geographical locations and time periods. A complex set of associations among climate variables, sociocultural variables, and other factors lead to collective violence. Because it is difficult to determine the relative contributions and interactions of these variables and factors in causing collective violence, it is challenging to develop statistical models for predicting climate-induced collective violence.

Multiple mechanisms could account for the association between climate change and collective violence. Hsiang and Burke describe, in an online appendix to their paper, eight non-exclusive pathways that may explain this association: government capacity, labor markets, inequality, food prices, altering of logistical constraints, misattribution of the causes of random events (such as to the performance of governments), psychological responses, and migration and urbanization.[42]

Scheffran et al. have developed an analytical framework of linkages among factors in the climate system, natural resources (such as land, ecosystems, and biodiversity), human security (such as food, health, and energy), and societal stability (such as violence and conflict).[43] This framework may enable future research studies to achieve a better understanding of the complex association between climate change and collective violence.

In addition to accounting for multiple variables and other factors, future research studies on the relationship between climate change and violence need to strike a balance in the size of the geographic areas and populations studied: they need to be large enough to gather a sufficient amount of data, but small enough so that the effects of subnational or local climatic conditions on the occurrence of violence are not diluted. In addition, they need to be based on adequate timeframes so that the effects of short-term weather events can be differentiated from the impacts of longer-term climate change.

Prevention of collective violence due to climate change

In addition to addressing climate change, measures need to be taken to reduce collective violence by addressing its other potential causes. These measures include preventing or reducing socioeconomic inequalities, violations of human rights (which are both a cause and an outcome of collective violence), and other forms of social injustice that are often the underlying causes of violence. These measures also include implementing non-violent approaches to resolving conflict, such as mediation.

Climate change is most likely to cause collective violence in situations and locations where these other factors are already present, especially in low-income countries and among socioeconomically disadvantaged people in high-income countries. Therefore, measures need to be developed and implemented to address special needs of these populations.

States' obligations

Because of their legal and moral obligations to pro-

tect human rights, States must work to prevent collective violence and to protect human rights that are threatened by collective violence due to climate change. States have legal and moral obligations to mitigate climate change and thereby reduce the risk of its adverse consequences to health and human rights. And, as convincingly described in a recent review article by two legal scholars, they have legal and moral obligations to promote and support adaptation to climate change.[44]

It is beyond the scope of this paper to describe in detail the measures that States can take to mitigate climate change. However, broadly speaking, they include measures to:

- reduce greenhouse gas emissions by economic incentives (such as a carbon tax and cap-and-trade programs) or legal penalties (for excessive emissions);
- increase the use of renewable forms of energy, such as wind, solar, and geothermal energy; and
- disseminate information about climate change and raise public awareness of its impact on health and human rights.

Perhaps most importantly, leaders in government, civil society, and business and labor will need to exert visionary leadership to mitigate and adapt to climate change, reduce the risks for collective violence, and protect health and human rights.

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References

1. United Nations General Assembly. Universal Declaration of Human Rights. United Nations, New York, December 10, 1948. Available at http://www.un.org/en/documents/udhr/ (accessed February 20, 2014); United Nations Department of Public Information, "General Assembly adopts resolution recognizing access to clean water, sanitation as human right, by recorded vote of 112 in favour, none against, 41 abstentions. (General Assembly/10967)." (New York: United Nations Department of Public Information, July 28, 2010.); United Nations General Assembly, "Convention on the Rights of the Child," (United Nations General Assembly, November 20, 1989.) ; United Nations General Assembly, "Convention on the Elimination of All Forms of Discrimination against Women," (United Nations General Assembly, December 18, 1979.); and United Nations General Assembly, "Convention on the Rights of Persons with Disabilities," (United Nations General Assembly, December 13, 2006.)

2. E.G. Krug, L.L. Dahlberg, J.A. Mercy et al. (eds) *World report on violence and health* (Geneva: World Health Organization, 2002). Available at http://whqlibdoc.who.int/publications/2002/9241545615_eng.pdf?ua=1 (accessed February 19, 2014).

3. WHO global consultation on violence and health. *Violence: a public health priority (WHO/EHA/SPI.POA.2)* (Geneva: World Health Organization, 1996).

4. Krug (see note 2), p. 215. Available at http://www.who.int/violence_injury_prevention/violence/global_campaign/en/chap8.pdf?ua=1 (accessed February 19, 2014).

5. V.W. Sidel and B.S. Levy, "Collective violence: War," in R. Detels, R. Beaglehole, M.A. Lansang, and M. Gulliford (eds). *Oxford textbook of public health* (Oxford: Oxford University Press, 2009, pp. 1367-1375); B.S. Levy and V.W. Sidel (eds*). War and public health (second edition)*. (New York: Oxford University Press, 2008).

6. D.D. Zhang, P. Brecke, H.F. Lee et al, "Global climate change, war, and population decline in recent human history," *Proceedings of the National Academy of Sciences* 104 (2007), pp. 19214-19219.

7. D.D. Zhang, H.F. Lee, C. Wang et al, "The causality analysis of climate change and large-scale human crisis," *Proceedings of the National Academy of Sciences* 108 (2011), pp. 17296-17301.

8. D.D. Zhang, J. Zhang, H.F. Lee, and Y. He, "Climate change and war frequency in eastern China over the last millennium," *Human Ecology* 35 (2007), pp. 403-414.

9. R.S.J. Tol and S. Wagner, "Climate change and violent conflict in Europe over the last millennium," *Climatic Change* 99 (2010), pp. 65-79.

10. S.M. Hsiang, K.C. Meng, and M.A. Cane, "Civil conflicts are associated with the global climate," *Nature* 476 (2011), pp. 438-441.

11. M.B. Burke, E. Miguel, S. Satyanath et al, "Warming

increases the risk of civil war in Africa," *Proceedings of the National Academy of Sciences* 106 (2009), pp. 20670-20674.

12. H. Buhaug, "Reply to Burke et al: Bias and climate war research," *Proceedings of the National Academy of Sciences* 107 (2010), pp. E186-E187.

13. J. O'Loughlin, F.D. Witmer, A.M. Linke et al, "Climate variability and conflict risk in East Africa, 1990-2009," *Proceedings of the National Academy of Sciences* 109 (2012), pp. 18344-18349.

14. J-F. Maystadt, O. Ecker, and A. Mabiso, "Extreme weather and civil war in Somalia: Does drought fuel conflict through livestock price shocks?" International Food Policy Research Institute (IFPRI Discussion Paper 01243) (2013). Available at http://www.ifpri.org/sites/default/files/publications/ifpridp01243.pdf.

15. M.A. Levy, C. Thorkelson, C. Vörösmarty et al, "Freshwater availability anomalies and outbreak of internal war: Results from a global spatial time series analysis," Human Security and Climate Change: An International Workshop, June 2005. Available at http://www.ciesin.org/pdf/waterconflict.pdf.

16. H. Fjelde and N. von Uexkull, "Climate triggers: Rainfall anomalies, vulnerability and communal conflict in sub-Saharan Africa," *Political Geography* 31 (2012), pp. 444-453.

17. M. Harari and E. La Ferrara, "Conflict, climate and cells: A disaggregated analysis," Discussion Paper Series No. 9277. Centre for Economic Policy Research (2013). Available at http://www.cepr.org/pubs/dps/DP9277.asp.

18. H. Sarsons, "Rainfall and conflict," Harvard Working Paper (2011). Available at http://www.econ.yale.edu/conference/neudc11/papers/paper_199.pdf (accessed February 19, 2014).

19. P.H. Gleick, "Water conflict chronology" in *The world's water, 2008-2009: The biennial report on freshwater resources* (Washington, DC: Island Press, 2009, pp. 151-196).

20. B.S. Levy and V.W. Sidel, "Water rights and water fights: Preventing and resolving conflicts before they boil over (Editorial)," *American Journal of Public Health* 101 (2011), pp. 778-780.

21. NPR staff, "How could a drought spark a civil war?" National Public Radio, Sept 8, 2013. Available at http://www.npr.org/2013/09/08/220438728/how-could-a-drought-spark-a-civil-war.

22. S. Johnstone and J. Mazo, "Global warming and the Arab Spring," *Survival* 53 (2011), pp. 11-17.

23. O.M. Theisen, H. Holtermann, and H. Buhaug, "Climate wars? Assessing the claim that drought breeds conflict," *International Security* 36 (2011), pp. 79-106.

24. O.M. Theisen, "Climate clashes? Weather variability, land pressure, and organized violence in Kenya, 1989-2004", *Journal of Peace Research* 49 (2012), pp. 81-96.

25. W.R. Adano, T. Dietz, K. Witsenburg, and F. Zaal, "Climate change, violent conflict and local institutions in Kenya's drylands," *Journal of Peace Research* 49 (2012), pp. 65-80.

26. F.E.O. Opiyo, O.V. Wasonga, J. Schilling, and S.M. Mureithi, "Resource-based conflicts in drought-prone Northwestern Kenya; The drivers and mitigation mechanisms," *Wudpecker Journal of Agricultural Research* 1 (2012), pp. 442-453.

27. T.A. Benjaminsen, K. Alinon, H. Buhaug, and J.T. Buseth, "Does climate change drive land-use conflicts in the Sahel?" *Journal of Peace Research* 49 (2012), pp. 97-111.

28. H. Buhaug, "Climate not to blame for African civil wars," *Proceedings of the National Academy of Sciences* 107 (2010), pp. 16477-16482.

29. I. Salehyan and C.S. Hendrix, "Climate shocks and political violence," Annual Convention of the International Studies Association, San Diego, Ca, 1 April 2012. Available at: http://cshendrix.files.wordpress.com/2007/03/s_h_climateshocks_forweb.pdf.

30. C.S. Hendrix and I. Salehyan, "Climate change, rainfall, and social conflict in Africa," *Journal of Peace Research* 49 (2012), pp. 35-50.

31. S.M. Hsiang, M. Burke, and E. Miguel, "Quantifying the influence of climate on human conflict," *Science* 341, 1235367 (2013), DOI: 10.1126/science.1235367.

32. J. Bohannon, "Study links climate change and violence, battle ensues," *Science* 341 (2013), pp. 444-445.

33. S.M. Hsiang, M. Burke, and E. Miguel, "Supplementary materials for quantifying the influence of climate on human conflict." Available at: https://www.sciencemag.org/content/suppl/2013/07/31/science.1235367.DC1/Hsiang.SM.pdf.

34. S.M. Hsiang and M. Burke, "Climate, conflict, and social stability: What does the evidence say?" *Climatic Change* 123 (2014), pp. 39-55.

35. S. Rahmstorf, "A semi-empirical approach to projecting future sea-level rise," *Science* 315 (2007), pp. 368-370. DOI: 10.1126/science.1135456.

36. UNHCR: The UN Refugee Agency, "Climate change could become the biggest driver of displacement: UNHCR chief, *News Stories* Dec 16, 2009. Available at http://www.unhcr.org/print/4b2910239.html.

37. C. Jakobeit and C. Methmann, "'Climate refugees' as dawning catastrophe? A critique of the dominant quest for numbers," in J. Scheffran, M. Brzoska, H.G. Brauch, et al (eds). *Climate change, human security and violent conflict: Challenges for societal stability, (Hexagon Series on Human and Environmental Security and Peace, Volume 8)* (Heidelberg, Germany: Springer-Verlag, 2012, pp. 301-314).

38. Human Rights Council, United Nations General Assembly, "Human rights and climate change: Resolution adopted by the Human Rights Council (18/22)" (New York: United Nations, October 17, 2011).

39. United Nations General Assembly (see note 1).

40. M.J. Toole, "Forced migrants: Refugees and internally

displaced persons," in B.S. Levy and V.W. Sidel (eds). *Social injustice and public health (Second Edition)*. (New York: Oxford University Press, 2013, p. 188).

41. Institute of Medicine, *The future of public health* (National Academy Press, Washington, DC, 1988).

42. S.M. Hsiang and M. Burke, "Appendix to: Climate, conflict, and social stability: What does the evidence say?" *Climatic Change* 123 (2014). Available at: http://link.springer.com/content/esm/art:10.1007/s10584-013-0868-3/file/MediaObjects/10584_2013_868_MOESM1_ESM.pdf.

43. J. Scheffran, P.M. Link, and J. Schilling, "Theories and models of climate-security interaction: Framework and application to a climate hot spot in North Africa," in J. Scheffran, M. Brzoska, H.G. Brauch et al (eds). *Climate change, human security and violent conflict: Challenges for societal stability, (Hexagon Series on Human and Environmental Security and Peace, Volume 8)* (Heidelberg, Germany: Springer-Verlag, 2012, pp. 91-131); J. Scheffran, M. Brzoska, J. Kominek et al. "Climate change and violent conflict," *Science* 336 (2012), pp. 869-871.

44. M.J. Hall and D.C. Weiss, "Avoiding adaptation apartheid: Climate change adaptation and human rights law," *The Yale Journal of International Law* 37 (2012), pp. 309-366.