Working Paper:
Going Beyond the Aggregations: A Regional Analysis of the Connection between Climate Change and Conflict

Tim Kovach[1]

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Abstract

In recent years, an ever-expanding collection of literature has emerged that explores the potential connections between climate change and armed conflict. While many actors within the policy community have suggested a clear link between these two, most scholars have rejected this largely deterministic, neo-Malthusian argument. Yet, despite this ongoing debate, few analyses have explored how the potential for climate change to affect the risk of violent conflict will vary based on climatic, political, historical, and socioeconomic variations between and within regions. This article adopts a regional lens on this issue in order to identify the existing circumstances and power relations within regions of the developing world and overlay these upon various climate projections for this century. This analysis demonstrates that, just as environmental issues and conflict do not always acknowledge borders, the nexus of political, social, and environmental changes within one state can spread within regions. Accordingly, policymakers should work proactively to mitigate climate change and help communities in the developing world prepare for its looming effects.

1. Introduction

In remarks to the United Nations Security Council, Tuvalu's Permanent Representative Afelee T. Pita stated, "The world has moved from a global threat called the cold war to what should now be considered the 'warming war.' Our conflict is not being fought with guns and missiles but with weapons from everyday life — chimney stacks and exhaust pipes."[2] As the significance of climate change and the role humans have made in generating it become clearer, several policymakers and researchers began to explore its potential connections to conflict. While some feel confident enough to speculate about the coming climate wars, many scholars have largely dismissed such causal connections as tenuous at best, if not hyperbolic. However, while researchers have written hundreds of reports on the potential links between climate and conflict, most of this research aggregated across regions. With a few exceptions, the literature

[1] MA Candidate, Global Environmental Policy Program, American University School of International Service; timothy.kovach@american.edu. This publication is a working paper. All analysis and conclusions are preliminary; I welcome comments and input.

[2] Remarks of Tuvalu to the UN Security Council, 5663rd meeting, 17 April 2007, UN doc. S/PV.5663 (Resumption 1), 7.

has tended either to analyze the potential for climate conflict at the global level or has drawn conclusions from one particular setting and attempted to generalize these across scales.[3]

In this article, I will disaggregate the potential connections between climate change and conflict across regions. As I will show, because the impacts of climate change will vary across time and space, the potential for climate change to affect the risk of violent conflict will also vary between and within regions. Taking this regional approach enables researchers to identify the existing circumstances and power relations within the region; overlaying these with climate projections provides a clearer picture of how climate change could play into such regional dynamics. This method also helps policymakers identify potential critical states for interventions.

The paper is organized as follows. First, I review a selection of the literature on this topic, which explores several of the potential important topics and pathways between climate change and conflict that commentators have identified, including direct temperature effects, precipitation changes, natural disasters, environmental degradation, demographic pressures, and migration. Next, I explore the projected impacts of climate change on a few critical regions in the developing world. Finally, I will summarize the main findings and provide a conclusion.

2. Literature Review

2.1 Temperature and Precipitation Effects

Despite broad claims that climate change represents a "threat multiplier" for violence, the pathway from climate change to conflict remains unclear.[4] Some have examined the direct effects of temperature changes on the likelihood of conflict. Burke et al have claimed that increasing temperatures will lead to a 54% rise in the likelihood of violent conflict by 2030.[5] Buhaug has directly challenged their findings, however, stating that temperature has been a poor predictor of historical conflict.[6] Hsiang et al have asserted that the risk of conflict doubles during El Niño years; they alleged that the El Niño-Southern Oscillation (ENSO) has affected 21% of all civil conflict.[7] Klomp and Bulte on the other hand, found no significant relationship between temperature changes and conflict.[8]

Others have explored changes in precipitation as a mechanism. Miguel, Satyanath, and Sergenti (2004) studied the influence that GDP plays on conflict in Africa, selecting changes in rainfall as a proxy for economic growth. Their results indicate that negative rainfall shocks

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[3] One key exception to this is Renate Schubert et al., *Climate change as a security risk* (London: Earthscan, 2008).
[4] CNA, "National security and the threat of climate change," (Alexandria, VA: CNA Corporation, 2007).
[5] Marshall B. Burke et al., "Warming increases the risk of civil war in Africa," *Proceedings of the National Academy of Sciences* 106, no. 49 (2009).
[6] Halvard Buhaug, "Climate not to blame for Africa's civil wars," *Proceedings of the National Academy of Sciences* 103, no. 38 (2010).
[7] Solomon M. Hsiang, Kyle C. Meng, and Mark A. Cane, "Civil conflicts are associated with the global climate," *Nature* 476(2011).
[8] Jeroen Klomp and Erwin Bulte, "Climate Change, Weather Shocks and Violent Conflict: A Critical Look at the Evidence" (paper presented at the 28th International Conference of Agricultural Economists, Foz do Iguaçu, Brazil, 2012).

significantly increase the risk of conflict onset, while positive shocks reduce it.[9] Ciccione dismissed their findings. He suggested that because rainfall shocks tend to revert to the mean, low rainfall growth could either represent a negative shock or a mean reversion after a positive shock. Accordingly, he finds that decreased rainfall actually reduces the risk of conflict.[10]

Climate science suggests the availability of renewable natural resources may change significantly in a greenhouse world. Accordingly, it is important to explore the relationship between conflict and resource scarcity. The State Failure Task Force found no direction connection between conflict risk and environmental degradation; however, they did find that environmental change contributed indirectly by affecting quality of life measures.[11] Raleigh and Urdal noted weak evidence, which suggests soil degradation may contribute to conflict, finding that very high levels of degradation double the risk.[12] Urdal also looked at the effects of environmental scarcity on conflict at a sub-national level in India. His results illustrated that conflict was more likely to occur in states with scarce productive land and declining agricultural wages. Gizelis and Wooden have shown some limited support for the ecological trap hypothesis, which argues that environmental degradation could lead to conflict, causing further environmental degradation. Their study noted that water scarcity undermines governance and democratic institutions. Accordingly, most water scarce countries are anocracies or autocracies, lifting their conflict risk.[13]

The vast majority of research into the relationship between water and violent conflict has focused on interstate conflict over shared river basins. Aaron Wolf has consistently demonstrated that cooperation is twice as likely as conflict to occur between co-riparian states. He argues that the last incidence of interstate conflict over water occurred in Sumeria 5,000 years ago.[14] Gleditsch et al. demonstrated the average likelihood of low-level conflict doubles between countries with shared river basins, but no significant relationship exists for interstate war.[15] Gizelis and Wooden placed particular emphasis on the role institutions play in controlling and/or preventing water scarcity. They found no clear link between scarcity and heightened conflict risk, arguing that effective institutions can prevent the development of water scarcity and minimize any potential conflict risk.[16]

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[9] Edward Miguel, Shanker Satyanath, and Ernest Sergenti, "Economic shocks and civil conflict: An instrumental variables approach," *Journal of Political Economy* 112, no. 4 (2004).
[10] Antonio Ciccione, "Economic Shocks and Civil Conflict: A Comment," *American Economic Journal: Applied Economics* 3, no. 4 (2011).
[11] Daniel C. Esty et al., "State failure task force report: Phase II findings," (McLean, VA: Science Applications International, 1998).
[12] Clionadh Raleigh and Henrik Urdal, "Climate Change, environmental degradation and armed conflict," *Political Geography* 26, no. 6 (2007).
[13] Theodora-Ismene Gizelis and Amanda E. Wooden, "Water resources, institutions, & intrastate conflict," *Political Geography* 29, no. 8 (2010).
[14] Aaron T. Wolf, "Conflict and cooperation along international waterways," *Water Policy* 1, no. 2 (1998); ———, "Transboundary Freshwater Dispute Database Project," *Water International* 24, no. 2 (1999).
[15] Nils Petter Gleditsch et al., "Conflicts over shared rivers: Resource scarcity or fuzzy boundaries?," *Political Geography* 25, no. 4 (2006).
[16] Gizelis and Wooden, "Water resources, institutions, & intrastate conflict."

Striking a more cautious outlook, Conca reminds us that the lack of conflict over water in the past does not necessarily indicate a conflict free future. He points out that while interstate arrangements over shared water resources have been positive to this point, they may actually contribute to conflict at a smaller scale by ignoring the needs and arrangements of users at the local level. In addition, he notes that water infrastructure projects hold a real potential for instigating conflict and/or unrest.[17] They can even facilitate conflict or violence. Iran, for instance, provided aid to Taliban fighters who attacked the Kajaki Dam on the Helmand River in Afghanistan. The dam limited water delivery to the Sistan Basin, an ecologically sensitive and collection of wetlands that straddle the border between the two countries.[18] Additionally, practitioners have noted localized conflict over water resources in several locations, including Somalia and the Democratic Republic of the Congo.[19]

2.2 Disasters and Conflict

Extreme weather events will constitute the primary indicator of climate change in the next few decades. The number of disasters has increased from 100 per decade from 1900-1940 to over 2800 per decade during the 1990s. Serious disasters have also risen four-fold during this period, while economic damages have increased 14-fold.[20] Surprisingly, however, there is a relative paucity of research on the connection between disasters and conflict occurrence, and the literature that does exist is ambiguous. Nel and Righarts argued that disasters could create opportunities for rebels to launch an attack and can generate or highlight grievances. Their results showed that countries suffering at least one disaster were almost one-third more likely to experience conflict.[21] Slettebak has challenged their findings; his research draws on earlier sociological research that emphasizes the ability of disasters to create unity among victims, driving down conflict risks.[22]

Bergholt and Lujala explored the effect of disasters on conflict through changes in economic growth. They found that, while disasters reduce GDP in the short term, they do not increase the risk of civil conflict.[23] Koubi et al also did not find any significant effect of climatic

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[17] Ken Conca, "Decoupling Water and Violent Conflict," *Issues in Science and Technology* 29, no. 1 (2012).
[18] Alireza Nader, a senior international analyst at the RAND Corporation, provided this example during the event "Finding a Regional Solution for Afghanistan" at the United States Institute of Peace on April 9, 2012.
[19] United Nations and World Bank, "Somalia Reconstruction and Development Programme: Deepening Peace and Reducing Poverty Volume I," (New York City: United Nations, 2008); UNEP, "The Democratic Republic of the Congo Post-Conflict Environmental Assessment: Synthesis for Policymakers," (Nairobi, Kenya: UNEP, 2010).
[20] Munich Re, "Annual Report 2002," (Munich: Munich Re, 2002).
[21] Philip Nel and Marjolein Righarts, "Natural Disasters and the Risk of Violent Civil Conflict," *International Studies Quarterly* 52, no. 1 (2008).
[22] Rune T Slettebak, "Don't blame the weather! Climate-related natural disasters and civil conflict," *Journal of Peace Research* 49, no. 1 (2012); Rune T Slettebak and Indra De Soysa, "High Temps, High Tempers? Weather-Related Natural Disasters & Civil Conflict," in *Conference on Climate Change and Security* (Trondheim, Norway2010).
[23] Drago Bergholt and Päivi Lujala, "Climate-related natural disasters, economic growth, and armed civil conflict," *Journal of Peace Research* 49, no. 1 (2012).

variability on GDP growth and civil conflict.[24] Other scholars have drawn different conclusions regarding the economic effects of climatic variability. Brown et al argue that such variability spawns risk aversion and a lack of investment in developing countries, which can create a debilitating poverty trap. They note, for example, poor farmers likely to forgo 18% of income as a hedge against climatic variability, while wealthier farmers give up just 0.4%.[25] Similarly, Dell, Jones, and Olken examined the effect of climatic changes on per capita income. They found that a 1°C temperature increase reduces GDP per capita by over 1% in developing countries; they project that per capita income will be roughly 50% lower by 2099 in these countries.[26]

2.3 Climate and Conflict: The Migration Effect

Commentators have touted the potential for climate change to generate significant displacement and migration for nearly three decades. Multiple reports have speculated wildly on the potential number of people displaced by climate change, with Christian Aid projecting as many as 1 billion.[27] Much of this existing research on environment/climate change and migration ignores the literature and strips agency from migrants. Migration is a highly contextualized issue, not some automatic response to external stresses.[28] The decision to migrate is based on the interaction of several factors, including economic opportunities, demographic changes, policies, social networks, livelihood security, and personal security/level of risk. Migration is often an important coping strategy, and it constitutes a key livelihood strategy for many groups, particularly pastoralists and rural farm laborers.[29]

Yet, some scholars have begun to piece together evidence that the environment plays a factor in the decision migrate. Environmental change is one of many factors, and it can play out in direct or indirect ways. For instance, changes in the availability of vital ecosystem services can be a driver for households that depend heavily on natural resources to make their livelihoods.[30] Warner and Afifi used a gravity model to study international flows of environmental migrants. Their model indicated that twelve of the thirteen variables they tested for environmental change were significantly positive for international migration. The only variable that was not significant – flooding – appears to be a significant driver of internal

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[24] Vally Koubi et al., "Climate variability, economic growth, and civil conflict," *Journal of Peace Research* 49, no. 1 (2012).
[25] Casey Brown et al., "An empirical analysis of the effects of climate variables on national level economic growth," in *Background Paper to the 2010 World Development Report* (Washington, DC: World Bank, 2008).
[26] Melissa Dell, Benjamin F. Jones, and Benjamin A. Olken, "Climate Shocks and Economic Growth: Evidence from the Last Half Century," in *NBER Working Paper No. 14132* (Cambridge, MA: National Bureau of Economic Research, 2008).
[27] Christian Aid, "Human Tide: the real migration crisis," (London: Christian Aid, 2007).
[28] Clionadh Raleigh, "The search for safety: The effects of conflict, poverty and ecological influences on migration in the developing world," *Global Environmental Change* 22, no. S1 (2011).
[29] Clionadh Raleigh, Lisa Jordan, and Idean Salehyan, "Assessing the impact of climate change on migration and conflict" (paper presented at the World Bank Seminar on Exploring the Social Dimensions of Climate Change, Washington, DC, 2008); Francois Gemenne, "Climate-induced population displacements in a 4°C+ world," *Philosophical Transactions of the Royal Society A* 393, no. 1934 (2011).
[30] Richard Black et al., "The effect of environmental change on human migration," *Global Environmental Change* 21, no. S1 (2011).

migration.[31] However, while the environment represents one factor, it is never *the* factor that precipitates movement.[32] Migration carries high costs and risks for individuals and is almost never the first choice in response to environmental challenges.[33]

Raleigh, Jordan, and Salehyan note than environmental migration follows a distinct pattern: it is largely internal, temporary, and nearby. Migrants moved an average of two miles in response to flooding in Bangladesh, and the vast majority returned shortly after the disaster had dissipated.[34] Gemenne emphasizes that the most significant impact of climate change may not be creating new flows but disrupting voluntary migration patterns. Climate change may make people feel compelled to move.[35] Yet, at the same time, the undermining of their asset base may force them to suffer *in situ*.[36] Those who see their livelihoods destroyed may undergo distress migration. Such migrants are typically highly vulnerable to exploitation.

Research does provide some evidence that migration and refugee flows can generate conflict. Salehyan and Gleditsch found evidence of a connection between conflict refugees and a spillover effect into neighboring states. The movement of refugees from one state to another can change the ethnic makeup of the host state, increase competition for resources within the host community, lead to the import of arms and violent ideologies, and help mobilize violent opposition against the host government.[37] Yet, there is still little evidence that environmental migration has generated conflict in the past. Reuveny has argued that 19/39 instances of environmental migration resulted in conflict.[38] One example is the ongoing conflict in Northeastern India between Bangladeshi immigrants and local communities. Approximately 12-17 million Bangladeshis have migrated to India since the 1970s.[39] As this number has increased, radical Hindus in Assam organized and began committing acts of communal violence. In response, Bangladeshi immigrants also organized, contributing to an escalating cycle of violence.[40] Despite this cautionary tale, Martin has demonstrated that disputes over resources between displaced populations and host communities do not necessarily generate conflict.[41]

3. Effects of Climate Change in the Developing World

[31] Tamer Afifi and Koko Warner, "The Impact of Environmental Degradation on Migration Flows across Countries," in *Working Paper 5/2008* (Bonn, Germany: United Nations University Institute for Environment and Human Security, 2008).
[32] Koko Warner et al., "Human Security, Climate Change, and Environmentally Induced Migration.," (Bonn, Germany: United Nations University - Institute for Environment and Human Security, 2008).
[33] Robert A. McLeman, "Settlement abandonment in the context of global environmental change," *Global Environmental Change* 21, Supplement 1, no. 0 (2011).
[34] Raleigh, Jordan, and Salehyan, "Assessing the impact of climate change on migration and conflict."
[35] Gemenne, "Climate-induced population displacements in a 4°C+ world."
[36] Ibid; Black et al., "The effect of environmental change on human migration."
[37] Idean Salehyan and Kristian Skrede Gleditsch, "Refugees and the spread of civil war," *International Organization* 60, no. 2 (2006).
[38] Rafael Reuveny, "Climate change-induced migration and violent conflict," *Political Geography* 26, no. 6 (2007).
[39] Ibid.
[40] Ashok Swain, "Environmental migration and conflict dynamics: Focus on developing regions," *Third World Quarterly* 17, no. 5 (1996).
[41] Adrian Martin, "Environmental conflict between refugee and host communities," *Journal of Peace Research* 42, no. 3 (2005).

It appears likely that the effects of climate change will exacerbate instability in regions around the globe. The most significant impacts are likely to hit those states that have the least capacity to deal with them. Such a situation will either call for additional international support or lead to additional suffering. This section outlines the projected negative consequences of climate change in Sub-Saharan Africa, the Middle East and North Africa (MENA), much of Asia, and Central America. These regions are of particular importance for three key reasons. First, they are likely to be the areas where the most significant direct impacts of climate change occur. Secondly, they are undergoing tremendous political, economic, and social change. Thirdly, they are the home to nearly all instances of civil conflict since the end of World War II. Accordingly, these four regions represent the areas of greatest concern for potential climate-related conflicts.

3.1 Impacts in Sub-Saharan Africa

Many researchers and policymakers have asserted that Sub-Saharan Africa will suffer more than any region from the changing climate. Perhaps the most significant and devastating effects will occur within the agricultural sector. Agriculture contributes an average of 21% of GDP for countries on the continent; it also accounts for 60% of total employment.[42] The lack of water infrastructure and advanced agricultural technologies heighten vulnerability to climate change. Ninety-six percent of cultivated land is rain-fed, and African farmers have the lowest uptake of high-yield varieties of crops in developing world.[43] Changes in precipitation on the continent will combine with increasing temperatures to reduce output. Approximately one-third of Africans are prone to drought, and 46% of total land area is vulnerable to desertification.[44] There remains high levels of uncertainty regarding the scale (and even the sign) of precipitation changes on the continent. Rainfall is likely to decrease in Southern Africa and increase in the Central tropics and the East. The projections for West Africa remain highly inconsistent. Ultimately, even in areas where precipitation may increase, changes in the frequency and intensity of rainfall events will stress vulnerable water systems. The total number of Africans facing water stress is projected to climb to 75-250 million by the 2020s and 350-600 million by the 2050s.[45]

Despite high levels of uncertainty, nearly all projections agree that there will be a reduction in agricultural output in Africa. Jones and Thornton find a 10% decrease in maize yields for smallholder farmers.[46] Roudier et al. found a median decrease of 11% among sixteen different studies. If warming increases beyond 3°C, they anticipate production will fall by an

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[42] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change," ed. M.L. Parry, et al. (Cambridge, UK: IPCC, 2007).
[43] Ibid; Philippe Roudier et al., "The impact of future climate change on West African crop yields: What does the recent literature say?," *Global Environmental Change* 21, no. 3 (2011).
[44] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."
[45] Ibid.
[46] Peter G. Jones and Phillip K. Thornton, "The potential impacts of climate change on maize production in Africa and Latin America in 2055," *Global Environmental Change* 13, no. 1 (2003).

additional four percent.[47] Schlenker and Lobell find more severe decreases for five staple crops across the continent. They estimate median changes of -22% (maize), -17% (sorghum), -17% (millet), -18% (groundnuts), and -8% (cassava). If the situation reaches the worst case scenario, they project yields may fall by 27-32% for four crops (excluding cassava).[48] African fisheries, which provide vital sources of protein along the coasts, will also see severely negative effects from global warming. Decreases will be the most severe in the northwest and in the Great Lakes region, while South Africa may see its fishery productivity fall by up to 50-60%.[49] Any substantial drop in fisheries production will take a particularly severe toll on West Africa.

Rapid population growth will further strain food security throughout Sub-Saharan Africa through 2050. Seven countries - Burkina Faso, Malawi, Mali, Niger, Somalia, Uganda, Tanzania, and Zambia – are projected to grow by at least 500% though 2100.[50] While population growth is not inherently deleterious on its own, a large, young population may present a challenge to fragile states in the region. The percentage of people in developing countries under the age of 25 will remain at 48% by 2050, above the critical threshold of 35% that Urdal has noted increases conflict risk.[51] Additionally, the strain that climate change will place on agriculture will likely threaten the livelihoods of many, including ex-combatants. Most post-conflict reintegration programs in African states have channeled ex-combatants into agriculture. Unless their livelihoods are climate-proofed, many of these former soldiers could find themselves "becoming resentful, unemployed farmers, and thus potential recruits…in a new conflict."[52]

Rising sea levels and climate-related disasters will likely generate profound consequences along the coasts. Coastal countries could see GDP losses of at least 14% from sea level rise (SLR) without adaptation. Half of Africa's 37 cities with more than one million people are located in low-lying coastal zones.[53] Rapid urbanization on the continent will elevate the number of people in harm's way substantially by 2050. Seventy-two percent of Sub-Saharan Africa's urban residents live in slums. Overall, the total number of urban residents on the continent will likely treble to 1.2 billion by 2050.[54] The disasters literature suggests that migrants to urban areas typically lack key components for resilience, including livelihood security and social capital.

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[47] Roudier et al., "The impact of future climate change on West African crop yields: What does the recent literature say?."
[48] Wolfram Schlenker and David B Lobell, "Robust negative impacts of climate change on African agriculture," *Environmental Research Letters* 5, no. 1 (2010).
[49] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."
[50] United Nations Population Division (UNFPA), "World Population Prospects: The 2010 Revision.," (New York City: United Nations, 2011).
[51] Henrik Urdal, "The devil in the demographics: the effect of youth bulges on domestic armed conflict, 1950-2000," *Social Development Papers: Conflict and Reconstruction Paper*, no. 14 (2004).
[52] Dan Smith and Janani Vivekananda, "Climate Change, Conflict and Fragility: Understanding the linkages, shaping effective responses," (London: International Alert, 2009).
[53] Sue Stolton, Nigel Dudley, and Jonathan Randall, "Natural Security: Protected areas and hazard mitigation," in *Arguments for Protection* (Gland, Switzerland: World Wide Fund for Nature, 2008).
[54] United Nations Population Division (UNFPA), "Population Distribution, Urbanization, Internal Migration and Development: An International Perspective," (New York City: United Nations, 2011).

Accordingly, rapid urbanization and coastal disaster risk may present existential threats to urban slum dwellers in Sub-Saharan Africa.[55]

SLR is also projected to affect negatively agriculture. A one meter rise could cause $500 million in damages to Kenya's mangoes, cashews, and coconut crops, while Guinea may see 17-30% of its rice fields inundated by 2050.[56] Drought will continue to represent a significant drag on economic growth in Africa due to climate change. Rainfall decreases in Sub-Saharan Africa from the 1960s to the 1990s reduced GDP per capita by 9-23%.[57] Climatic variability has contributed to ongoing poverty in many African states. In Ethiopia, this variability has reduced economic growth by more than one-third.[58] If the effects of climate change undermine the economic growth which the continent has seen in recent years, it could continue the horrific trend which sees the average Sub-Saharan African become twice as poor every 25 years.

Several researchers have portrayed the Sahel as ground zero for climate-related conflict. Raleigh and Kniveton analyzed the connection between rainfall shocks and violence in the region. For rebels, significant violence appears to occur after significantly negative rainfall shocks. Communal violence among tribes, on the other hand, tends to escalate after positive rainfall shocks. Hendrix and Salehyan also found support for the influence of positive rainfall shocks on conflict, noting that they can produce flooding and mudslides that damage critical infrastructure and limit government capacity to respond to violence.[59]

Additionally, warming is likely to increase the already substantial burden of disease within Sub-Saharan Africa. Currently, between 700,000 and 2.7 million people die from malaria every year, 75% of whom are African children. The continent's GDP would be roughly one-third higher today had the disease been cured in 1970.[60] Malaria was responsible for the loss of 45 million disability-adjusted life years (DALYs) in 2000. This disease burden costs Africa around $12 billion per year.[61] Recurrent floods and drought can increase the risk and distribution of several vector-borne diseases.[62] The IPCC tentatively estimates that the distribution of malaria may increase 5-7% throughout Sub-Saharan Africa, spreading primarily into the highland areas

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[55] International Federation of Red Cross and Red Crescent Societies (IFRC), "World Disasters Report 2004: Focus on Community Resilience," (Geneva: IFRC, 2004).
[56] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."
[57] Salvador Barrios, Bazoumana Ouattara, and Eric Strobl, "The impact of climatic change on agricultural production: Is it different for Africa?," *Food Policy* 33, no. 4 (2008).
[58] Brown et al., "An empirical analysis of the effects of climate variables on national level economic growth."
[59] Cullen S Hendrix and Idean Salehyan, "Climate change, rainfall, and social conflict in Africa," *Journal of Peace Research* 49, no. 1 (2012).
[60] Kurt M. Campbell et al., "The Age of Consequences: The Foreign Policy and National Security Implications of Global Climate Change," (Washington, DC: Center for Strategic & International Studies and the Center for New American Security, 2007).
[61] Kwadwo Asenso-Okyere et al., "The Linkages between Agriculture and Malaria: Issues for Policy, Research, and Capacity Strengthening," in *IFPRI Discussion Paper 00861* (Washington, DC: International Food Policy Research Institute (IFPRI), 2009).
[62] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."

of East and Southern Africa.[63] Because these regions are currently at elevations above the transmission line, individuals here are not resistant, increasing the risk of severe epidemics. This additional disease burden will likely reduce the adaptive capacity and resilience of Africans, leaving them more vulnerable to exogenous shocks.

3.2 Impacts in the Middle East and North Africa

It seems likely that climate change will have a significant effect upon the Middle East and North Africa (MENA), given the region's considerable environmental and social challenges. Every country within MENA currently experiences water stress or water scarcity.[64] The combined effects of decreased rainfall – the IPCC estimates precipitation will decrease approximately 20% – lack of renewable water resources, and continued rapid population growth will exacerbate this situation further.[65] Egypt is at particular risk. It will see its population double to 160 million by 2050, even as crop yields for soy and rice may fall by 28% and 11%, respectively.[66] The World Bank has also projected that one meter of SLR could displace 10.5% of Egyptians living along the Nile River basin and delta.[67] Rising seas will not only inundate these areas, they will also facilitate further saltwater intrusion from the Mediterranean, increasing soil salinity and damaging crop production.

Changes in precipitation and streamflow will negatively affect Israel and its neighbors. Analysts project decreases in the flow of the Yarmuk and Jordan Rivers, which could further undermine water security in the region.[68] Water has been a major point of contention within the Middle East over the years, becoming a target during the Six Days War. Despite this, Israel and Jordan have cooperated over its shared water resources since that point, and it remains unlikely to spark confrontation between the two.[69] Additionally, Israel has significantly increased its available water resources through desalination, wastewater recycling, and "virtual water" from commodity imports. The situation remains far worse in Gaza and the West Bank, where Palestinians have limited access to and control over their water sources. Many wells in the occupied territories have dried up or become too contaminated to drink from them. Overall, water withdrawals per capita for Palestinians are approximately one-quarter of those for Israelis and continue to fall.[70] This politicization of water places Palestinians at serious risk from climatic changes in the region.

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[63] Ibid.
[64] United Nations Environment Programme (UNEP), "Vital Water Graphics: An Overview of the State of the World's Fresh and Marine Waters. 2nd Edition," (Nairobi, Kenya: UNEP, 2008).
[65] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."
[66] Ibid.
[67] Susmita Dasgupta et al., "The impact of sea level rise on developing countries: a comparative analysis," *World Bank policy research working paper*, no. 4136 (2007).
[68] CNA, "National security and the threat of climate change."
[69] Steve Lonergan, "Resources and Conflict: Examples in the Middle East," in *Conflict and the Environment*, ed. Nils Petter Gleditsch (New York City: Springer, 1997).
[70] World Bank, "West Bank and Gaza: Assessment of Restrictions on Palestinian Water Sector Development," (Washington, DC: World Bank, 2009).

MENA will be particularly vulnerable to food price shocks due to its heavy reliance on grain imports. The Sahara region may see agricultural losses equivalent to 2-7% of GDP by 2100, increasing this dependence further.[71] IFPRI projects significant increases in food prices through 2050, ranging from 31.2% for rice to 100.7% for maize.[72] There has been a close correlation between food price spikes and political instability in import-dependent countries in recent years, as evinced by the 2008 Haitian food riots and the 2007 Tortilla Crisis in Mexico.

A handful of researchers have connected the Arab Spring to food price spikes. Johnstone and Mazo pointed out that food prices hit an all-time high in the midst of the uprisings, as the price of wheat jumped from $4 per bushel in July 2010 to $8.50-9 per bushel by February.[73] These price spikes occurred following decreased grain production in Canada and Australia following excessive rains, in China from an historic drought, and in Ukraine and Russia after intense heat wave and wildfires in July 2010.[74] Climate scientists have attributed the Russian heat wave to climate change.[75] The Tunisian protests that helped spark the wave kicked off after a poor fruit vendor committed suicide through self-immolation. A severe, multi-year drought in Syria caused three-fourths of agricultural households to suffer total crop loss by 2008.[76] In the aftermath of this devastation, 1.2 to 1.5 million people migrated into Syria's cities, perhaps contributing to the current civil war (Saade, 2010). As Johnstone and Mazo (2011, 16) note, "Global warming may not have caused the Arab Spring, but it may have made it come earlier."

3.3 Climate Change in Asia

Serious, though highly differentiated, effects will play out across Asia as a result of climate change. Precipitation will largely increase across the continent, though seasonal decreases will occur in Central and South Asia. Extreme weather and climatic variability will also plague much of region, as climatologists anticipate a 10-20% increase in tropical cyclone intensity with a 2-4°C rise in sea surface temperatures.[77] The combined effects of increased temperatures and extreme precipitation will negatively impact agriculture. In Bangladesh, rice and wheat production is expected to decline by 8% and 32%, respectively, by 2050. Declining yields and increasing global food prices will likely elevate the number of malnourished Asians substantially. An additional 49 million, 132 million and 266 million Asians may be hungry by

[71] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."
[72] Clemens Breisinger, *Food security, farming, and climate change to 2050: Scenarios, results, policy options* (International Food Policy Research Insitute, 2010).
[73] Sarah Johnstone and Jeffrey Mazo, "Global Warming and the Arab Spring," *Survival* 53, no. 2 (2011).
[74] Troy Sternberg, "Chinese drought, bread and the Arab Spring," *Applied Geography* 34, no. 0 (2012).
[75] Stefan Rahmstorf and Dim Coumou, "Increase of extreme events in a warming world," *Proceedings of the National Academy of Sciences* 108, no. 44 (2011); F. E. L. Otto et al., "Reconciling two approaches to attribution of the 2010 Russian heat wave," *Geophysical Research Letters* 39, no. 4 (2012).
[76] Wadid Erian, Bassem Katlan, and Ouldbdey Babah, "Drought vulnerability in the Arab region: Special case study: Syria," in *Background paper prepared for the 2011 Global Assessment Report on Disaster Risk Reduction* (Geneva: United Nations International Strategy Disaster Reduction Secretariat, 2010).
[77] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."

2020, 2050 and 2080, respectively.[78] A 2006 internal Chinese report projected that wheat, maize and rice yields could decrease by as much as 37% within the next few decades. This outcome is exacerbated by the fact that Gobi Desert has grown by 52,400km² from 1994-99, threatening the livelihoods of 400 million Chinese.[79]

Changes in water resources will likely be the way that climate change affects the majority of Asians. The Mekong River may experience increased maximum flows of 34-51% in the basin and 16-19% in the delta, while its minimum flows will fall 17-24% and 26-29%, respectively. These changes threaten to increase flood risks during the maximum flows and fall below the levels needed for withdrawals during low periods.[80] North China, historically the country's wheat belt, is projected to see a 20-40% reduction in runoff per capita by the end of the century. India, which will surpass China as the world's largest country by mid-century, will become water stressed by 2025, as its water availability declines to just 1140 m³ by 2050.[81]

The Himalayan glaciers – the water towers of Asia – will continue to shrink as the Tibetan Plateau heats up. This increased melting may lead to additional water availability in the short-term, but it is also likely to contribute to severe flooding, such as that which devastated Pakistan in 2010 and 2011. As the glaciers approach their tipping points, however, the 1.2 billion South Asians that depend on them will be in peril. Continued development of dams and other large water infrastructure projects in China and India will almost certain heighten the vulnerability of their downstream neighbors further. Reduced precipitation and streamflow will also likely significantly reduce hydropower output in Central Asia. Long-term reductions in output would undermine existing water-export agreements between upstream and downstream states, which have been central to post-Cold War stability in the region.[82]Accelerating hydrocarbon production in Central Asia will increase industrial water demand in the region, which may create localized conflict over access to and distribution of water resources. All told, the IPCC estimates that 120 million to 1.2 billion Asians will experience increased water stress by the 2020s, and an additional 185-981 million will join the ranks by the 2050s.[83]

East Asia/Pacific and South Asia are, along with MENA, the most vulnerable regions to rising seas. Approximately 74,020km² of total land area and more than 37 million people may face the direct impacts of SLR in East Asia. Vietnam is at the greatest risk, as one meter of SLR would affect 10.8% of its population and nearly 6% of its GDP.[84] The low-lying coastal zones of South Asia are also acutely endangered. With one meter of SLR and a 10% increase in tropical

[78] Ibid.
[79] Campbell et al., "The Age of Consequences: The Foreign Policy and National Security Implications of Global Climate Change."
[80] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."
[81] Ibid.
[82] World Bank, "Adapting to Climate Change in Europe and Central Asia," (Washington, DC: World Bank, 2009).
[83] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."
[84] Dasgupta et al., "The impact of sea level rise on developing countries: a comparative analysis."

storm intensity, coastal areas vulnerable to storm surges in the region will increase by 23-33%.[85] The IPCC estimates that a 2°C rise in temperatures could increase flooded areas of Bangladesh by 23-39%.[86] Finally, SLR poses a near existential threat to many small island developing states (SIDS), particularly those in the Indian Ocean and the Pacific. But it is not rising seas, per se, that pose the greatest threat to the inhabitability of the islands. Rather, the greatest threat comes from the increased saltwater intrusion that SLR facilitates. Accordingly, SLR could reduce the available water resources of these countries to such an extent that, by 2050, they would be insufficient to support their populations during low rainfall periods.[87]

Manmade environmental change and development projects will likely increase substantially Asia's vulnerability to the impacts of climate change. Mangroves, for instance, provide coastal protection against storms and waves that will become even more crucial as sea levels rise and tropical storms accelerate. According to UNEP, mangrove forests that have a density of 30 trees per 100 m² in 100m belt can reduce tsunami flow rates by up to 90%. This effect became clear during the 2004 Indian Ocean Tsunami, which severely affected 80-100% of villages with degraded mangroves but just 7% of villages with intact mangrove forests.[88] Yet, despite their value, 35% of mangrove forests have disappeared in the last two decades.[89]

Large-scale water infrastructure projects and deforestation will also heighten vulnerability. Bangladesh has constructed more than 200 polders on its internal rivers since the 1970s, each of which prevents the delivery of critical silt loads to recharge its river deltas. As a result, these delta areas experience four millimeters of land subsidence annually, elevating relative SLR. The combination of conflict, corruption, and its climate change also combined to exacerbate significantly the 2010 Indus River Floods in Pakistan. Large-scale logging, including timber extraction by militant groups and timber mafias in the restive Northwest, has contributed to a deforestation rate of 4.6% per annum.[90] This trend worsened disaster effects and has further fed into a vicious cycle of instability and violence.

3.4 The Effects of Climate Change in Central America

It appears nearly certain that Central America, too, will suffer from climate change. The evidence base for Latin America appears much more mixed and uncertain, however, making it difficult to project the effects with any level of confidence. Despite this fact, the combined

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[85] Tapas Paul and Jane Nishida, "The Impacts of Climate Change in the South Asia Region," *World Bank Annual Review* (2008).
[86] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."
[87] ———, "Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change," ed. P. K. Pachauri and A. Reisinger (Geneva, Switzerland: IPCC, 2007).
[88] UNEP, "Economic Analysis of Mangrove Forests: A case study in Gazi Bay, Kenya," (Nairobi, Kenya: UNEP, 2011).
[89] Millennium Ecosystem Assessment, "Ecosystems and Human Well-being: Synthesis," (Washington, DC: Island Press, 2005).
[90] Shaheen Rafi Khan and Shahrukh Rafi Khan, "Assessing poverty–deforestation links: Evidence from Swat, Pakistan," *Ecological Economics* 68, no. 10 (2009).

effects of higher temperatures, decreased precipitation, and additional extreme weather events will not be positive. Agriculture represents 10% of Latin America's regional GDP, and the IPCC forecasts falling yields for multiple crops in several countries. Within Central America, half of agricultural land is subject to desertification by 2050, greatly threatening food production and agricultural livelihoods.[91] Droughts throughout the region will likely intensify both in duration and intensity. As such, severe to extreme drought will become the norm for much of the continental US and Mexico. As Wehner et al project, as these regions move towards a new climatic equilibrium, "not having drought is the unusual event."[92] Additionally, drought may increase migration rates 6-9.6% by 2080.[93]

This increased dryness will occur in conjunction with more frequent extreme events. Climate-related disasters occurred 24 times more often between 1970-1999 and 2000-2005. Without taking serious efforts to mitigate climate change, disaster losses in Latin America could increase to $300 billion per year.[94] Central American governments have limited financial resources to offset disaster losses, which limits their economic growth. For example, the GDP in Honduras was 6% lower in 2003 – five years after Hurricane Mitch – than it was projected to be prior to the storm.[95] The storm forced many poor families to sell off critical livelihood assets. While the wealthy were able to stabilize and return to pre-storm wealth levels within a matter of months, thousands of poor households fell into a debilitating poverty trap.[96]

Highly inequitable land distribution will further challenge Central America in the face of climate change. The region's historical reliance on export-oriented agriculture has contributed to the consolidation of land into the hands of a small number of wealthy plantation owners. This process forced many rural peasants onto marginal lands, where they are highly vulnerable to floods and landslides.[97] In 1979, 2.6% of the population in Guatemala controlled 64.5% of land. These patterns of exclusion and marginalization fed into the wave of civil conflicts and revolutions that swept the region during the Cold War. Since the end of these conflicts, however, land issues have not improved; by 2000, just 1.5% of Guatemalans controlled 62.5% of land.[98]

The failure to address land inequity has undermined the reintegration of thousands of ex-combatants, contributing to the persistent crime plaguing the region today. While it remains unlikely that climate-related disasters will spark renewed civil conflict in the region, disasters

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[91] IPCC, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."
[92] Michael Wehner et al., "Projections of future drought in the Continental United States and Mexico," *Journal of Hydrometeorology* 12, no. 6 (2011): 1369.
[93] Shuaizhang Feng, Alan B. Krueger, and Michael Oppenheimer, "Linkages among climate change, crop yields and Mexico–US cross-border migration," *Proceedings of the National Academy of Sciences* 107, no. 32 (2010).
[94] Munich Re, "Annual Report 2002."
[95] Reinhard Mechler et al., "Assessing the Financial Vulnerability to Climate-Related Natural Hazards," in *Policy Research Working Paper 5232* (Washington, DC: World Bank, 2010).
[96] Michael R. Carter et al., "Poverty Traps and Natural Disasters in Ethiopia and Honduras," *World Development* 35, no. 5 (2007).
[97] Ben Wisner et al., *At Risk: Natural Hazards, People's Vulnerability and Disasters*, 2nd ed. (New York City: Routledge, 2004).
[98] International Crisis Group, "Guatemala: Squeezed Between Crime and Impunity," in *Latin American Report N°33* (Brussels: International Crisis Group, 2010).

have played a role in the region's conflict history. Following the 1972 Managua earthquake, the failure of the Somoza regime to respond effectively to the widespread suffering of its people contributed to its eventual fall to the Sandinistas.[99]

4. Conclusion

This article has connected climate change projections to the socioeconomic, political, and conflict dynamics within Sub-Saharan Africa, the Middle East and North Africa, Asia, and Central America. It has demonstrated that the impacts of climate change and their potential connections to conflict will vary among and within geopolitical regions. Given that climate change and, often, conflict do not acknowledge national borders, this regional approach provides a clearer sense of how the political, social, and environmental changes within one state can spread into neighboring states. While it remains unlikely that climate change will directly contribute to the onset of armed conflict, it may act as a "threat multiplier," adding on to extant conflict risks in the developing world.[100]

This additive effect is most likely to occur where the negative impacts of climate change overlap with political instability, recent conflict history, demographic pressures, horizontal inequalities, food insecurity, and/or environmental degradation. Accordingly, I have sought to overlay climate change projections with these social, economic, political and conflict dynamics in order to identify potential hotspots of instability. The conflict in Darfur may represent a model for potential armed conflicts in a greenhouse world. Climatic changes, particularly severe drought, did not generate the conflict; a number of political, social, and economic factors were the primary drivers, including the political manipulation of ethnic rivalries by elites. However, the majority of local conflicts over shared resources have occurred during drought years, illustrating the potential effect of climatic shocks on existing conflict risks.[101]

It is important to note that this article focuses almost exclusively on the vulnerabilities and risks connected to climate change and conflict. As such, I have left out adaptive capacity, which is critical for any analysis of risk. Failing to consider these capacities and the coping mechanisms that individuals utilize can increase the risk that humanitarian interventions may reinforce or even exacerbate existing social inequities and tensions. Several government institutions and local nongovernmental organizations throughout the developing world are proactively working to enhance the resilience of populations at risk in a greenhouse world. The Dominican Disaster Management Committee, for instance, is an excellent example of a grassroots, community-based effort to reduce disaster risk and enhance the adaptive capacity of local communities.[102] At the same time, however, one must avoid romanticizing the resilience of

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[99] Richard Stuart Olson and Vincent T. Gawronski, "From Disaster Event to Political Crisis: A "5C+A" Framework for Analysis," *International Studies Perspectives* 11, no. 3 (2010).
[100] CNA, "National security and the threat of climate change."
[101] Jeffrey Mazo, *Climate Conflict: How Global Warming Threatens Security and What to Do About It*. (New York City: Routledge, 2010).
[102] Mark Pelling, Alpaslan Özerdem, and Sultan Barakat, "The macro-economic impact of disasters," *Progress in Development Studies* 2, no. 4 (2002).

vulnerable populations; while communities are often accustomed to external stressors, vicious cycles of violence, marginalization, and climate change may overwhelm their ability to cope.

Ultimately, both climate change and conflict represent incredibly complex, dynamic, and multi-faceted trends. While the literature suggests that we cannot assume that environmental change will precipitate violence, it may not be wise to plan for our greenhouse future by looking through the rearview mirror. Instead, the high levels of uncertainty and complexity involved in this question suggest that we should work proactively to mitigate climatic change and help communities in the developing world prepare for the looming effects of environmental, social, political, and environmental change. In this light, developed countries should focus on working to strengthen the institutional and social resilience of developing states to the looming specter of climate change.