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CLIMATE CHANGE AND AFRICAN POLITICAL STABILITY PROGRAM

This paper is produced as part of the Strauss Center's program on Climate Change and African Political Stability (CCAPS). The program conducts research in three core areas, seeking to investigate where and how climate change poses threats to stability in Africa, identify strategies to support accountable and effective governance in Africa, and evaluate the effectiveness of international aid to help African societies adapt to climate change.

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LOCATING CLIMATE INSECURITY:

WHERE ARE THE MOST VULNERABLE PLACES IN AFRICA?

Executive Summary

- Africa is among the continents most vulnerable to climate change—partly because of geography, and partly because of the low adaptive capacity of many African countries.
- Much of the current discussion on Africa, climate change, and security is of limited practical use to policymakers, for multiple reasons: a lack of reliable data, a narrow focus on conflict as the only security outcome of interest, and insufficient attention to variations in vulnerability at the sub-national level.
- To address those shortcomings, the CCAPS program sought to identify which areas in Africa are most vulnerable to climate change—and why—at the most detailed scale possible.
- When it comes to prioritizing limited resources, policymakers should focus first on the regions and countries where the effects of climate change, if poorly managed, could lead to a large number of deaths—that is, areas characterized by not only high physical vulnerability to climate hazards, but also dense populations, low household and community resilience, and weak governance.
- Parts of the continent—such as the Democratic Republic of the Congo (DRC), Sudan, and Somalia—may be less physically exposed to climate-related hazards, but more vulnerable due to other factors, such as weak governance and low household and community resilience. In these regions, support for basic governance capacity and conflict resolution is as important as disaster prevention and targeted assistance for risk reduction such as early warning systems, better building codes, and drought resistant agriculture.
- Other parts of the continent—such as South Africa and the coastal region of northern Africa—have high physical exposure to climate hazards, but are likely less vulnerable than other regions thanks to more robust social and political resources. Support for these countries should come in the form of information-sharing to help African leaders mobilize domestic resources most effectively.

Africa: A Continent at Risk

Policymakers and scholars increasingly recognize that climate change is more than an environmental problem: it constitutes a security challenge that may be as significant as any faced before.

This is especially true for Africa, which is understood to be among the continents most vulnerable to climate change. Africa's vulnerability is driven partly by geography—by the fact that its location and environmental features make it susceptible to climate change's most severe physical effects. But the continent's vulnerability also derives from the low adaptive capacity of many African countries—the result of longstanding challenges in countries' economies, healthcare and education systems, infrastructure, and governance.

Yet, even though climate change is widely recognized as a threat to African security and stability, the ongoing discussion is frequently undercut by several key limitations.

First, while policy analysts and academics alike have examined causal connections between climate change and conflict, and while many reports have assessed correlations between the expected effects of climate change—such as drought, rainfall variation, disasters, and migration—and the onset of violent conflict, the applicability of these models has been limited by a lack of adequate data and mixed conclusions.

Second, experts have struggled to establish a common definition of what constitutes a security problem. Some refer to a concept of security that encompasses almost any harm to human welfare, and is consequently too broad to be of practical use. Others propose an overly narrow concept of security that focuses only on violent conflict and thus misses important security challenges other than conflict.

This is more than an issue of semantics.

In poor, fragile states—like many of those in Africa—climate shocks and swift-onset meteorological hazards can pose severe threats to domestic security by compromising a state's monopoly of force within its borders. In the absence of effective humanitarian relief, the destruction of infrastructure and interruption of services can trigger such desperation that the populace resorts to stealing or rioting to secure necessities. These risks to state control are compounded if citizens exploit the absence of a security presence to loot for personal gain. Moreover, disasters may provide focal points around which government opponents may rally.

Extreme weather events also represent important security concerns for external actors, with militaries frequently deployed to provide humanitarian relief. This diversion of military resources represents an opportunity cost by preventing troops and equipment from being deployed for other purposes.

> It is not enough to say 'Ethiopia is vulnerable' without explaining which parts of Ethiopia are particularly vulnerable and why.

Third, and perhaps most importantly, climate-related challenges are not uniformly distributed throughout Africa. Research announcing that "Africa is vulnerable to climate change," or even "Ethiopia is vulnerable," without explaining which parts of Ethiopia are particularly vulnerable and why, is of limited value to the international policy community. It is of even less use to Africans themselves, in helping them prioritize scarce resources. Decision-makers need research that is evidence-based and detail-oriented to help them target aid in the most effective way possible.

With these issues in mind, the Strauss Center's program on Climate Change and African Political Stability (CCAPS) set out to fill the gaps in current research. This study develops a model that identifies in detail which parts of Africa are most vulnerable to climate change—and why. The aim is to provide a specific, accurate methodology that will help African leaders and international policymakers manage their resources and deliver adaptation assistance to the regions that need it most.

From Geography to Governance: Identifying the Sources of Vulnerability

What makes a place potentially vulnerable to climate change?

As the literature on vulnerability has demonstrated, vulnerability to extreme weather events is only partially a function of physical exposure. In addition to being located in areas prone to flooding, drought, or other hazards, communities may also be marginalized from services, infrastructure, and levers of power that might otherwise help them in times of need. They may lack adequate public infrastructure—such as roads, piped water, sanitation, and electricity—or access to healthcare, education, and other basic services. These risks may be compounded by a lack of political representation, poor governance, or a history of violence in the country.

With these factors in mind, this study identified four main sources or "baskets" of vulnerability: (1) *physical exposure to climate-related hazards*, (2) *population density*, (3) *household and community resilience*, and (4) *governance and political violence*. These sources of vulnerability are described as "baskets" since they typically each contain multiple indicators. Within three of the four baskets, several different indicators were identified that contribute to that dimension of vulnerability.

PHYSICAL EXPOSURE TO CLIMATE-RELATED HAZARDS

Geographic location makes some countries more susceptible than others to climate change impacts. Risk factors vary across the continent, as well as within countries. For example, low-lying coastal areas are vulnerable to permanent or temporary flooding as sea levels rise.

Because global climate models vary widely in their projections of future local weather patterns for Africa, the best proxy for future vulnerability, at this point, is historical exposure.

This study draws on data measuring the historical frequency and magnitude of climate-related hazards, including cyclone winds, floods, wildfires, and droughts. For chronically arid areas, the study also measures the variation in rainfall to identify areas that may experience water stress even if they are not technically experiencing droughts. The study also includes a measure of low-elevation coastal zones that may be susceptible to future sea level rise and higher storm surges. A complete list of indicators used to assess vulnerability to climate-related hazards is included in Appendix A.

POPULATION DENSITY

This study includes population density as one of the four key sources of vulnerability. All else being equal, policymakers will be more concerned when climate change affects large numbers of people. In the event of an extreme weather event, large numbers of people needing supplies and services—including food, water, shelter, and medical care—can overwhelm existing facilities and resources. Additionally, if the effects of climate change force rural populations to migrate to urban areas, the sudden population shift may put further strain on local systems.

HOUSEHOLD AND COMMUNITY RESILIENCE

While physical exposure and population density are integral parts of vulnerability, the impact of climate change on African populations also depends on other factors. The first line of defense for many people will be the resources they have at the household and community level to protect themselves from physical hazards and respond in the event of climate-related emergencies like floods, droughts, or wildfires.

Communities where many people are sick, or lack access to health care and basic amenities, are likely to be less resilient than those that are healthier and have greater access to services. In areas with low levels of literacy and education, people may have fewer entrepreneurial skills to help them avoid or cope with climate hazards.

This study uses a range of indicators measuring health, education, and access to healthcare and daily necessities to assess vulnerability due to low household and community resilience. See Appendix B for the complete list of indicators.

GOVERNANCE AND POLITICAL VIOLENCE

Whether individuals experience the worst effects of climate-related events will partially depend on the quality of governance in the country in which they live. Government support can help communities prepare for and adapt to the expected impacts of climate change. And when extreme weather events do occur, national governments are often called to respond—supplementing local communities' efforts to save people from rising waters, rescue survivors from rubble, and provide emergency food, water, and shelter.

Given these important responsibilities, weak governance can lead to fatal consequences. If governments are unable or unwilling to meet the needs of their citizens, an otherwise manageable natural phenomenon can become a disaster, putting large numbers of people at risk of death from starvation, disease, or exposure to the elements. In such societies, disorder and instability may also follow exposure to climate hazards.

A history of violence in a country can also complicate the task of providing relief supplies.

To assess this dimension of vulnerability, this study thus uses a range of indicators measuring government responsiveness and effectiveness, political stability, openness to external assistance, and violence. See Appendix C for the complete list of indicators.

Mapping Vulnerability Across Africa

After collecting data on physical hazards, population density, household and community resilience, and governance and political violence, this study mapped the impact of these factors across Africa. The composite picture shows where chronic climate security vulnerability is located—that is, where these four sources of vulnerability coalesce.

As Figure 1 shows, Africa's areas of most severe composite vulnerability include Somalia, Sierra Leone, Guinea, Sudan, and parts of the Democratic Republic of the Congo (DRC).

The Mapping Process

This study identified four main sources or "baskets" of vulnerability: (1) *physical exposure to climate-related hazards*, (2) *population density*, (3) *household and community resilience*, and (4) *governance and political violence*. These sources of vulnerability are described as "baskets" since they typically each contain multiple indicators. Within three of the four baskets, several different indicators were identified that contribute to that dimension of vulnerability.

Because each of the variables in this model was initially measured using different scales, the first step was to standardize the values based on their distribution. All of the variables within a given basket of vulnerability were then summed and mapped to create composite maps for *physical exposure to climate-related hazards, household and community resilience, and governance and political violence*. Population density was mapped individually and treated as its own basket.

Composite scores for each of the four baskets were then standardized with values of one through five, based on quintile rank. The four baskets (*physical exposure to climate-related hazards, population density, household and community resilience, governance and political violence*) were then summed together, with each receiving equal weight, to create a composite vulnerability map. Finally, the composite vulnerability scores were classified into quintiles, or five parts with a roughly equal area in each, and mapped to create a final composite vulnerability map (Figure 1). The first quintile represents the areas with the lowest vulnerability scores and the fifth quintile represents the areas with the highest vulnerability scores.

Each quintile represents the distribution of twenty percent of the observations. Each observation is a pixel, a square on the map of Africa, which can be represented by a number, meant to represent an underlying indicator like infant mortality. For example, the twenty percent of pixels with the lowest infant mortality rate go into Quintile 1, the best performers. The next twenty percent of pixels with the second-best infant mortality rate go into Quintile 2. The classification proceeds until the last twenty percent of observations, the worst performers, go into the fifth quintile. All of Africa is mapped in this fashion, except for unpopulated areas that are excluded from analysis.

In the process of creating the composite vulnerability map, the impact of adding each basket was evaluated. Figure 6 shows the value-added of the more complex map that incorporates social and political indicators compared to simpler frameworks based purely on physical exposure and/or population.

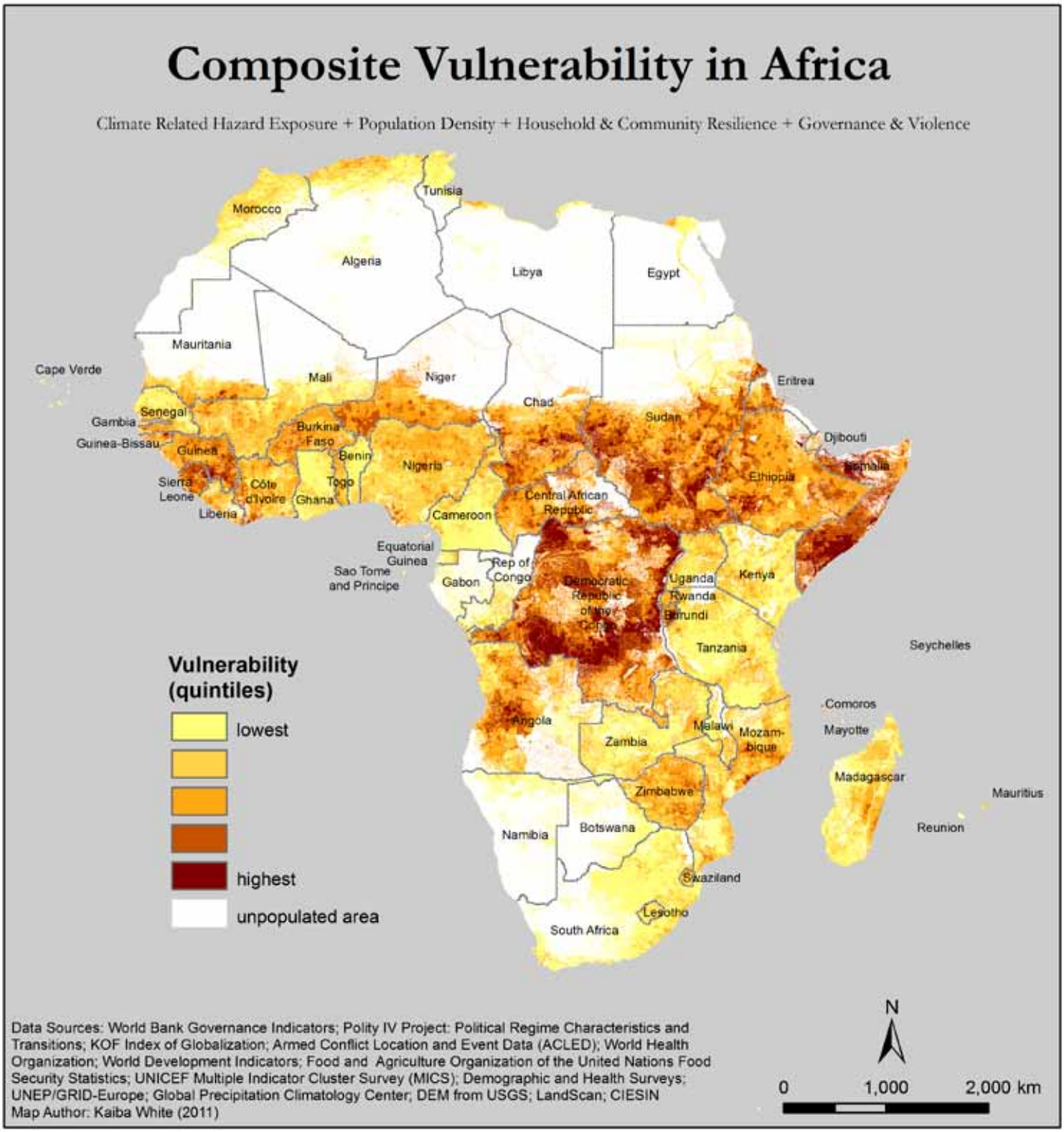

Figure 1. The composite picture highlights chronic climate security vulnerability by identifying where these four sources of vulnerability coalesce.

Tailoring Policy Responses

By examining the sources of vulnerability, this holistic approach can inform more finely-tuned policies and interventions. Figure 1 highlights four regions of high overall vulnerability: Somalia, Sierra Leone, Guinea, Sudan, and the DRC.

Somalia has the largest amount of its populated area in the fifth quintile of any country in Africa (nearly 26%), as shown in Appendix D. While its physical exposure is moderate—rooted mostly in drought and persistently scarce rains, its particular vulnerability is largely driven by low resilience and very low levels of governance. Given the continued absence of a functioning government, Somalia ranked among the highest in the composite index in terms of vulnerabilities in both resilience and governance.

As Figure 2 illustrates, Somalia's most vulnerable areas are located in and around the capital of Mogadishu and the far north. From a policy perspective, assistance in building basic governance and stability should be the highest priorities, as little else can be achieved in their absence.

Mapping vulnerability offers evidence-based, detailed analysis to help target aid in the most effective way possible.

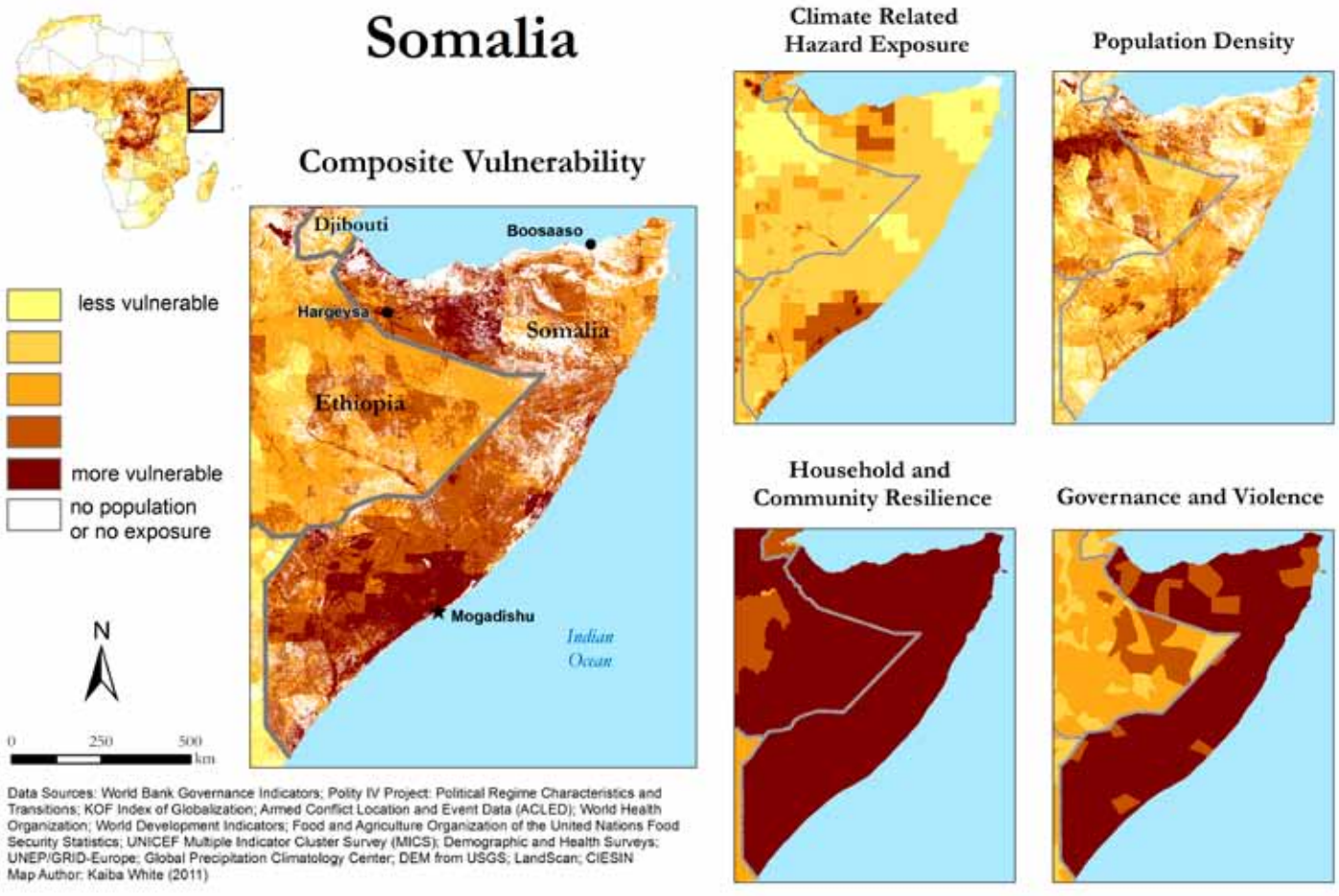

Figure 2. Somalia's most vulnerable areas are located in and around the capital of Mogadishu and the far north. Insecurity in these areas is driven by all four dimensions of vulnerability, but particularly by low resilience and poor governance.

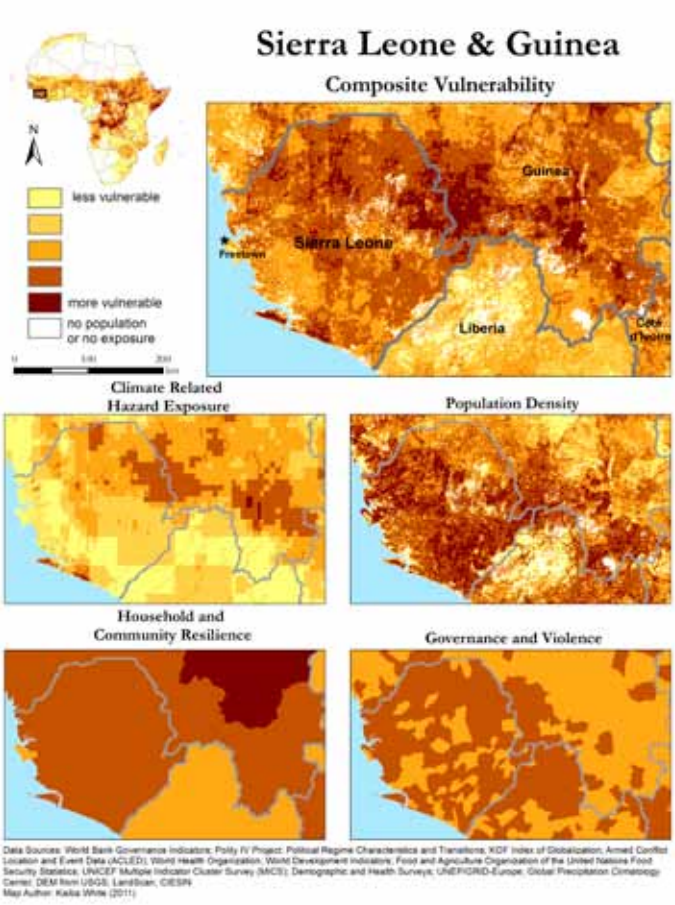

Figure 3. Vulnerability in Sierra Leone and Guinea is driven by all four sources of vulnerability, but particularly high population density and low resilience.

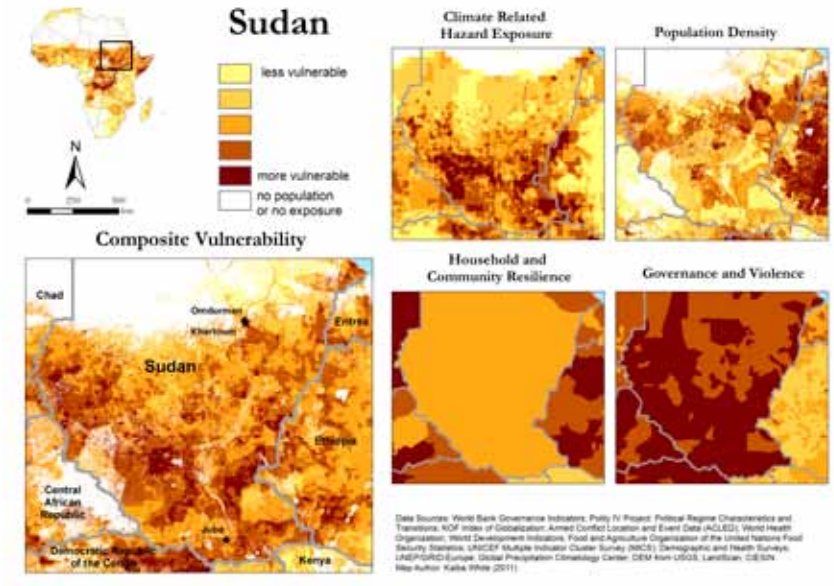

Figure 4. Poor governance and high physical exposure—primarily from drought, persistent scarce rains, and wildfires—are the main drivers of climate vulnerability in Sudan.

The West African countries of Sierra Leone and Guinea are particularly vulnerable to climate security concerns. Figure 3 shows that overall vulnerability in Sierra Leone and Guinea is driven by all four sources of vulnerability. More than 10.6% of Sierra Leone's populated area is located in the fifth most vulnerable quintile, while 4.7% of Guinea's area is located in the fifth quintile of composite vulnerability. Their high physical vulnerability is largely a product of wildfires, droughts, and, in the case of Sierra Leone, low-elevation coastal zones. Their low resilience stems from low educational attainment, poor access to clean water, and limited availability of health care.

While all four sources of vulnerability contributed to severe vulnerability in Sierra Leone and Guinea, high population density and low resilience were narrowly the most important sources of both countries' areas of highest vulnerability, as shown in Appendix D. In both countries, priority assistance should include investments in health to improve local community resilience.

Southern Sudan, having voted for independence in 2011, may find itself facing intense challenges associated with climate change. In pre-partition Sudan, 8.5% of the populated areas were in the fifth quintile of composite vulnerability. Figure 4 shows that poor governance and high physical exposure—primarily from drought, persistent scarce rains, and wildfires—were the main drivers of Sudan's vulnerability.

As Southern Sudan's new government finds its footing, donors can prioritize investments in early warning systems, fire protection, rainwater collection, and other capacity-building measures that protect against water scarcity.

Finally, the DRC had more than 24% of its populated areas in the fifth quintile of vulnerability, with high vulnerability driven principally by low household and community resilience and poor governance. In terms of physical exposure, the DRC was particularly drought prone in the last two decades in the North and especially fire prone in the South (see Figure 5).

As with Somalia, high-priority policy areas for the DRC include a continued focus on bringing an end to conflict and improving basic governance capacity.

Other pockets of high vulnerability exist in Burundi, Eritrea, Ethiopia, Angola, and Niger, where low scores on human development coincide with poor governance and considerable climate hazard risks from droughts, scarce rain, and wildfires.

As Appendix D depicts, most of these countries experienced a number of disasters in recent decades.

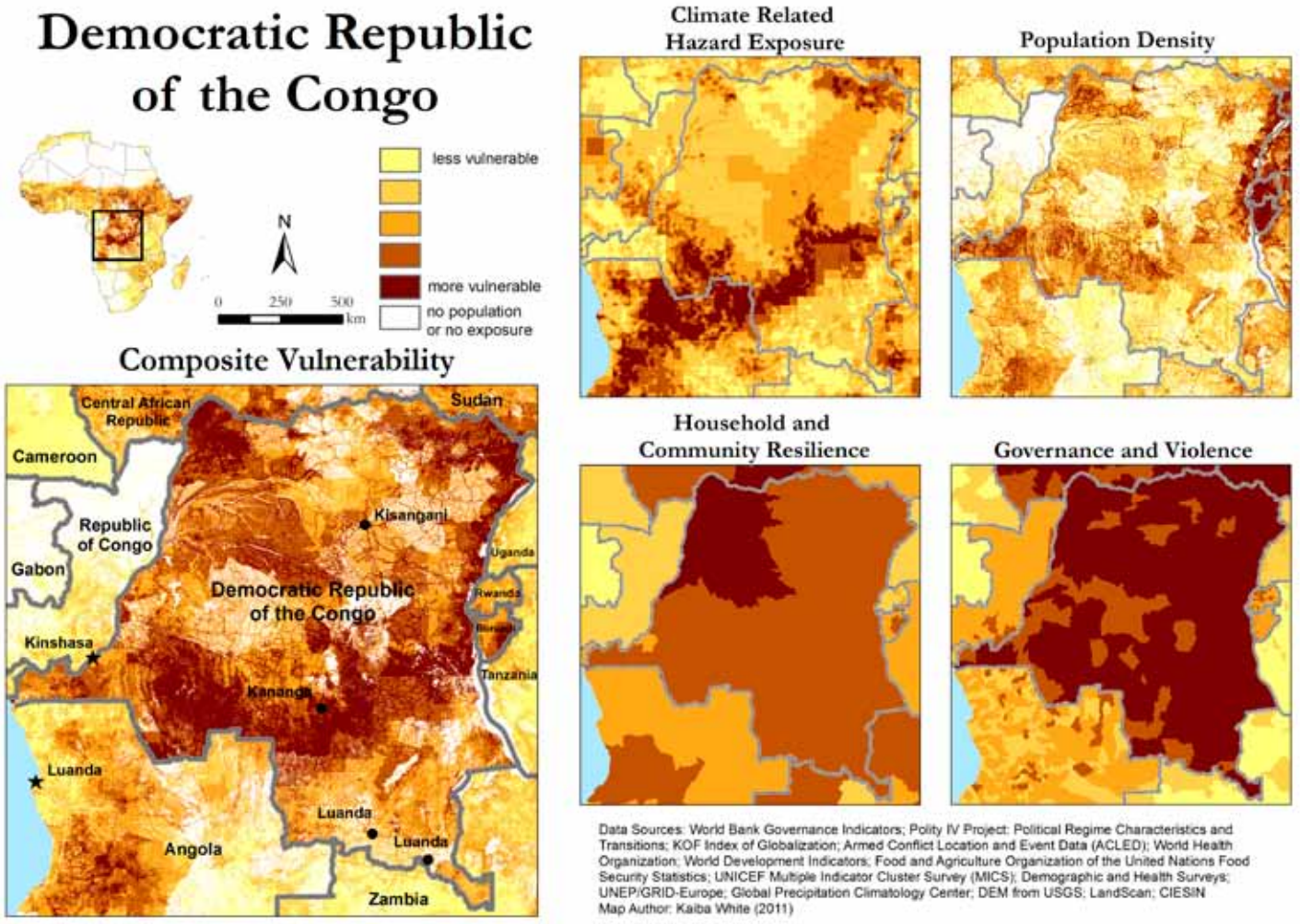

Figure 5. Vulnerability in the DRC is driven principally by low household and community resilience and poor governance.

Assessing the Findings

The value-added of this more complex portrait of vulnerability becomes clear when the contributions of all four sources of vulnerability (physical exposure, population density, resilience, and governance) are compared to just two sources (physical exposure and population density). In Figure 6, researchers subtract the first two sources of vulnerability—physical exposure and population density—from the composite map shown in Figure 1. This new map in Figure 6 highlights the places on the continent that become more (or less) vulnerable when measures of household and community resilience, and governance and political violence, are included in the overall analysis.

As Figure 6 shows, South Africa and the Mediterranean coastline appear far less vulnerable when measures of resilience and governance are considered, whereas parts of Niger, Sudan, and Somalia appear far more vulnerable, given their low levels of resilience and poor governance.

The assumption of additive, equally weighted baskets is clearly a convenience and simplification. However, absent compelling reasons to change the weights, the equal weight assumption is common among composite indices. Nevertheless, this study assessed the stability of the composite map by altering the weights. To the extent that some areas remain in the top quintile of vulnerability across multiple specifications, these areas constitute important regions of concern.

Figure 7 depicts four alternative weighting schemes and demonstrates that the countries and sub-regions of concern remain consistent across various model weights.

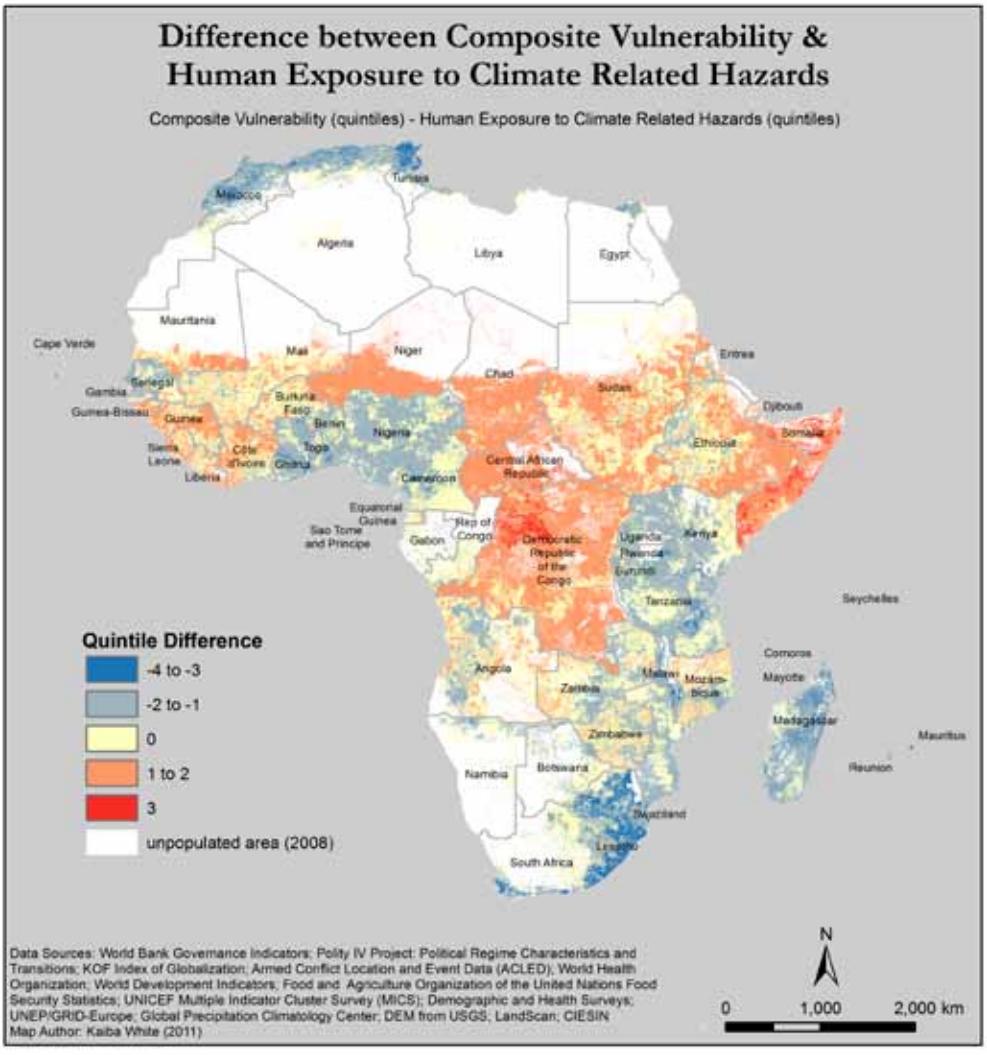

Figure 6. South Africa and the Mediterranean coastline appear far less vulnerable when measures of resilience and governance are considered, whereas parts of Niger, Sudan, and Somalia appear far more vulnerable, given their low levels of resilience and poor governance.

Policy Implications

Analyzing sub-national climate security vulnerability can help African and international policymakers identify potential trouble spots on the continent, and focus research, attention, and distribution of resources. Three main policy implications emerge from this mapping effort.

First, resources and attention should be directed to the areas and countries where modest to high physical vulnerability to climate change is likely to be most damaging due to weak governance and low household and community resilience. Unfortunately, the countries most in need of climate adaptation assistance—Somalia, Southern Sudan, the DRC, Sierra Leone, and Guinea—tend to have the lowest governance capacity to ensure that the funds are spent well. While assistance for disaster prevention and risk reduction is essential, support for building basic government capacity and conflict resolution may be equally important for a country's ability to address climate-related challenges.

Second, a number of countries in northern and southern Africa may be more physically vulnerable to climate change than others but possess more capacity at the household and governance levels to cope with these problems. Support for these countries should include more information-sharing to help them address their physical vulnerabilities largely through mobilization of their own internal resources.

Third, more focus should be placed on developing systems for tracking weather patterns in Africa. Models and projections of future climate risks in Africa have not converged on a consensus about the expected effects for much of the continent. Support for basic weather monitoring, as well as more sophisticated climate modeling, is essential.

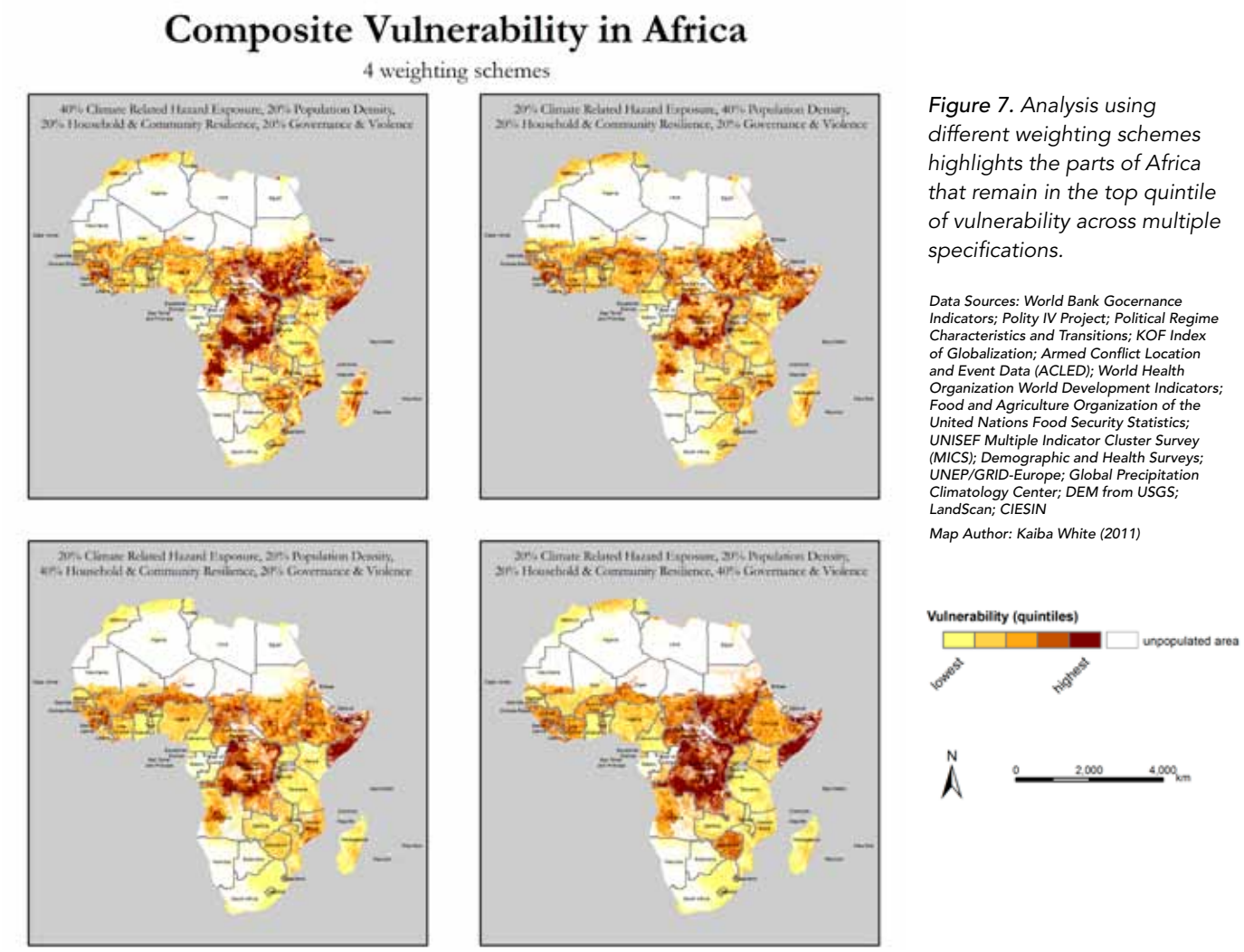

Figure 7. Analysis using different weighting schemes highlights the parts of Africa that remain in the top quintile of vulnerability across multiple specifications.

Data Sources: World Bank Gocernance Indicators; Polity IV Project; Political Regime Characteristics and Transitions; KOF Index of Globalization; Armed Conflict Location and Event Data (ACLED); World Health Organization World Development Indicators; Food and Agriculture Organization of the United Nations Food Security Statistics; UNISEF Multiple Indicator Cluster Survey (MICS); Demographic and Health Surveys; UNEP/GRID-Europe; Global Precipitation Climatology Center; DEM from USGS; LandScan; CIESIN

Map Author: Kaiba White (2011)

APPENDICES

APPENDIX A. Indicators Used to Assess Physical Exposure to Climate-Related Hazards

Hazard Type (weight)	Data Source	Years of Data Used
Cyclone Winds (.16)	UNEP/GRID-Europe	1975-2007
Floods (.16)	UNEP/GRID-Europe	1999-2007
Wildfires (.16)	UNEP/GRID-Europe	1997-2008
Aridity (Coefficient of Variation) (.16)	UNEP/GRID-Europe	1951-2004
Droughts (.16)	Global Precipitation Climatology Center	1980-2004
Inundation (Coastal elevation) (.16)	USGS DEM	1996

APPENDIX B. Indicators Used to Assess Household and Community Resilience

Variable (weight)	Indicator (weight)	Source	Years of Data Used
Education (.25)	Literacy rate, adult total (% of people ages 15 and above) (.125)	World Development Indicators	2008; 2007 for Burkina Faso; 2006 for Algeria, Egypt, Mali and Senegal; 2005 for Niger; no data for Djibouti, Republic of the Congo, or Somalia
	School enrollment, primary (% gross) (.125)	World Development Indicators	2006-2009; 2004 for Gabon
Health (.25)	Infant mortality rate adjusted to national 2000 UNICEF rate (.125)	CIESIN	1991-2003
	Life expectancy at birth (years) both sexes (.125)	World Development Indicators	2008
Daily Necessities (.25)	Percentage of children underweight (more than two standard deviations below the mean weight-for-age score of the NCHS/CDC/WHO international reference population) (.125)	CIESIN	1991-2003
	Population with sustainable access to improved drinking water sources total (%) (.125)	USAID Demographic & Health Surveys; UNICEF Multiple Indicator Cluster Surveys; World Development Indicators	DHS 2000-2008; MICS 2005-2006; WDI 2008 for Algeria, Botswana, Cape Verde, Comoros, Eritrea, Mauritius, and Tunisia; WDI 2005 for Equatorial Guinea; WDI 2000 for Libya
Access to Healthcare (.25)	Health expenditure per capita (current US$) (.125)	World Development Indicators	2007; 2005 for Zimbabwe; no data for Somalia
	Nursing and midwifery personnel density (per 10,000 population) (.125)	World Development Indicators	2004-2008; 2003 for Lesotho; 2002 for Kenya

APPENDIX C. Indicators Used to Assess Governance and Political Violence

Variable	Indicator (weight)	Source	Years of Data Used
Government Responsiveness	Voice and Accountability (.2)	World Governance Indicators	2007, 2008, 2009
Government Response Capacity	Government Effectiveness (.2)	World Governance Indicators	2007, 2008, 2009
Openness to External Assistance	Globalization Index (.2)	KOF Index of Globalization	2009
Political Stability	Polity Variance (.1)	Polity IV Project	1999-2008
	Number of Stable Years (as of 2008) (.1)	Polity IV Project	1855-2008
Presence of Violence	Battles and Violence Against Civilians (.2)	Armed Conflict Location and Events Dataset (ACLED)	1997-2009

APPENDIX D. Areas of Highest Vulnerability

Country	% Contribution to Fifth Vulnerability Quintile				Total	% of Populated Area in Fifth Quintile	# of Climate-Related CRED Disasters 1995-2008
	Climate-Related Hazard Exposure	Population Density	Household and Community Resilience	Governance and Violence			
Angola	28.12	27.08	24.17	20.63	100	2.30	20
Burundi	25.42	30.55	24.32	19.72	100	14.85	23
DRC	21.99	23.05	25.20	29.76	100	24.15	18
Eritrea	22.10	29.38	24.77	23.75	100	5.92	4
Ethiopia	25.75	28.66	29.41	16.17	100	2.60	42
Guinea	23.04	27.72	26.43	22.81	100	4.73	7
Niger	14.24	30.56	31.10	24.11	100	0.47	13
Sierra Leone	22.12	28.67	24.77	24.44	100	10.65	5
Somalia	19.13	21.34	30.00	29.52	100	25.84	26
Sudan	27.26	23.67	18.58	30.48	100	8.53	25

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[10] The CCAPS program was initiated in June 2009, and development of this vulnerability assessment model represents the first effort at combined GIS-based sub-national climate security maps, using existing data sources. Other members of the CCAPS team are coding new data: team member Clionadh Raleigh has developed the Armed Conflict and Location Event Data (ACLED); team members Idean Salehyan and Cullen Hendrix are coding data on a range of social conflict events in their new Social Conflict in Africa Database (SCAD); and team members Catherine Weaver, J. Timmons Roberts, and Michael Tierney are geo-coding climate adaptation projects under a collaboration between CCAPS and AidData.org.

[11] The map of sub-national climate security vulnerability of Africa presented here updates an earlier version of this model from fall 2010 by including several new data sources and indicators including: (1) a new data source on droughts; (2) a new indicator for areas with chronic low rainfall; (3) a new sub-national indicator of access to improved water sources; (4) a new indicator for sub-national violence; (5) revised metrics of government effectiveness and voice and accountability which reflect a 3-year weighted average; and (6) an alternate, more fine-grained indicator of population density. The original model can be found in: Joshua W. Busby et al., *Locating Climate Insecurity: Where Are the Most Vulnerable Places in Africa?* (Austin: Robert S. Strauss Center for International Security and Law, 2010).

[12] Basher and Briceño, *Climate Change and Africa*, 276.

[13] The CCAPS research team is collaborating with climate modelers from the Jackson School of Geosciences at the University of Texas at Austin to produce mid 21st century regional climate projections for Africa. With more narrow resolution and a nearer-term time horizon, this regional model is likely to have more applicability in policy planning than the current global climate models. In the meantime, the first point of departure is identifying which places are historically most vulnerable to climate-related hazards.

[14] The population density indicator utilized the LandScan (2008)TM High Resolution global Population Data Set copyrighted by UT-Battelle, LLC, operator of Oak Ridge National Laboratory under Contract No. DE-AC05-00OR22725 with the United States Department of Energy.

[15] Two other climate vulnerability indices are available from Maplecroft and One World Trust. However, their choice of indicator weights does not appear to have a strong empirical foundation. See www.maplecroft.com/themes/cc. Rob Davies and Stephanie Midgley, *Health and Food Security Risk Profile Mapping in Southern Africa* (Cape Town: One World Sustainable Investments, 2009).

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