CLIMATE SECURITY VULNERABILITY IN ASIA 1.0[1]

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CEPSA
COMPLEX EMERGENCIES AND POLITICAL STABILITY IN ASIA

RESEARCH BRIEF NO. 1

ABOUT THE STRAUSS CENTER

The Robert S. Strauss Center for International Security and Law integrates expertise from across the University of Texas at Austin, as well as from the private and public sectors, in pursuit of practical solutions to emerging international challenges.

ABOUT THE CEPSA PROGRAM

The Strauss Center's program on Complex Emergencies and Political Stability in Asia (CEPSA) explores the causes and dynamics of complex emergencies in Asia and potential strategies for response. In doing so, the program investigates the diverse forces that contribute to climate-related disaster vulnerability and complex emergencies in Asia, the implications of such events for local and regional security, and how investments in preparedness can minimize these impacts and build resilience. CEPSA is a multi-year initiative funded by the U.S. Department of Defense's Minerva Initiative, a university-based, social science research program focused on areas of strategic importance to national security policy.

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Introduction

Due in large part to high population densities along rivers and low-elevation coastal zones, Asian countries have among the highest numbers of people exposed to the impacts of climate-related hazards and, thus, at greatest risk of mass death. Floods, droughts, and storms have always tested civilian governments and international humanitarian aid agencies. However, climate change threatens to make the problem worse by increasing the intensity and possibly the frequency of climate-related hazards.[2]

Increasingly, both national and foreign militaries are called upon to carry out humanitarian assistance operations in the event of major climate shocks. Because of the potentially destabilizing consequences of a changing climate, an emergent discussion about climate change and security has developed in policy circles and among academics.

Though experiencing the lion's share of disaster fatalities and affected populations, Asian countries receive a small proportion of disaster assistance from donors such as the United States. At the same time, Asia remains understudied in the climate and security literature, particularly among academics.

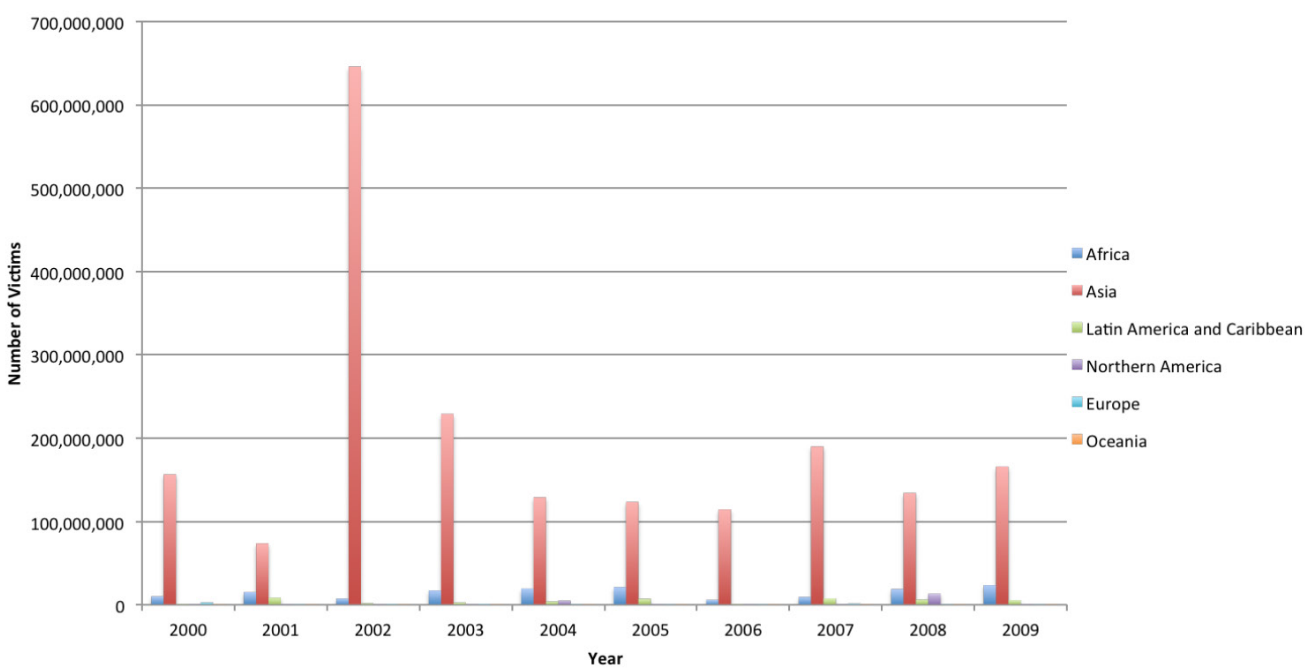
Building on a model developed by the Climate Change and African Political Stability Program (CCAPS), this brief presents the preliminary findings of the effort to map sub-national climate security vulnerability in 11 countries in South and Southeast Asia. Study countries include six countries in South Asia (Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka) and five countries in Southeast Asia (Cambodia, Laos, Myanmar, Thailand, and Vietnam).

The findings of this Asian Climate Security Vulnerability Model 1.0 (ACSV) suggest that much of Bangladesh, parts of southern Myanmar (the Ayeyarwady region), and parts of southern and northwest Pakistan (Sindh, Balochistan, and Khyber Pakhtunkhwa) are the most vulnerable locations to climate change from a climate security perspective.

Regional Overview

Climate-related hazards such as floods, wildfires, storms, droughts, and hurricanes endanger the lives of millions around the world. In some situations, resilient communities and capable governments are able to prevent exposure to a natural hazard from becoming a *disaster*, a situation where the population experiences large impacts from the event. However, in other

Figure 1: Reported Number of Victims of Climate-Related Disasters by Region



instances, an absence of investments in risk reduction and preparedness make communities vulnerable to large-scale loss of life, humanitarian emergencies from the dislocation of local populations, and emergent food insecurity and disease risks. In such situations, civilian agencies are often overwhelmed.

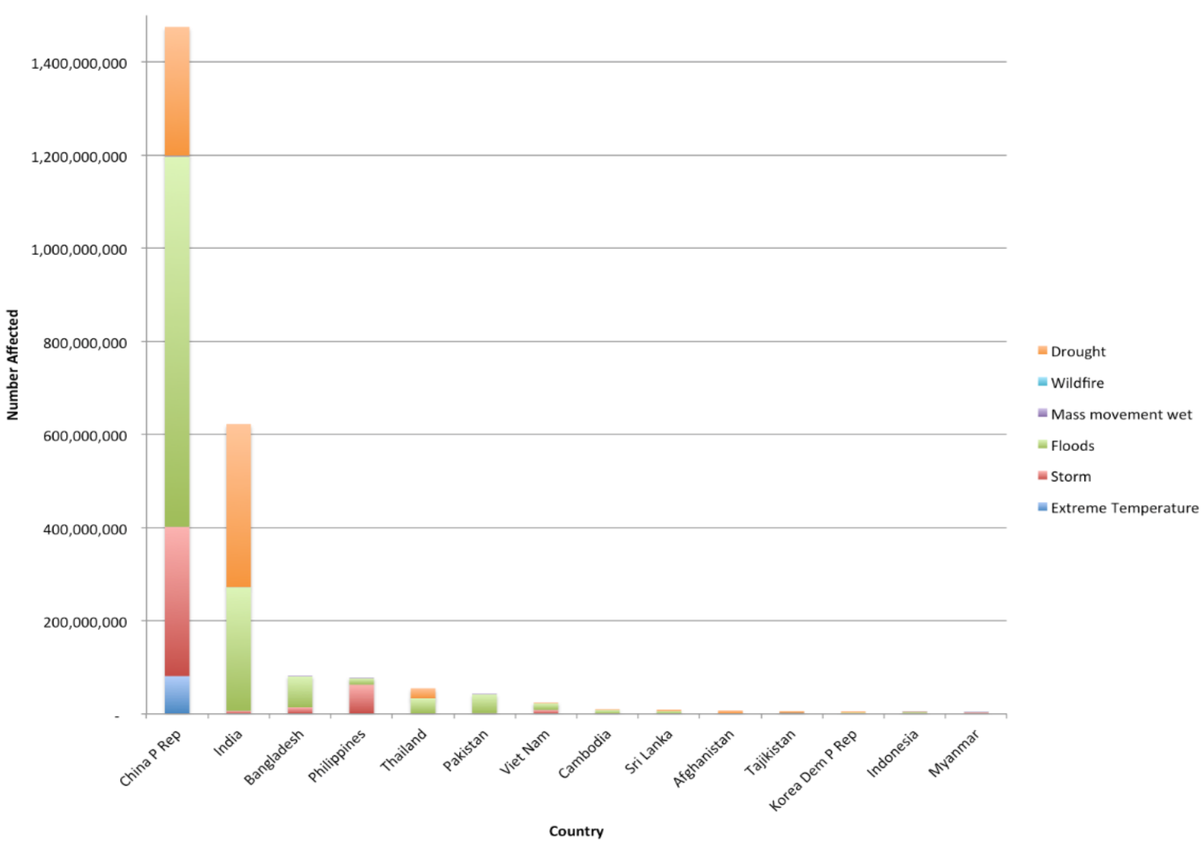
Asia is particularly vulnerable to the effects of disasters because of its large population and the concentration of large numbers in mega-cities, defined as cities with a population in excess of ten million people. 60% of the world's population lives in Asia. By one count, as many as 17 of 26 megacities are located in Asia.[3] As a consequence, of the 2.22 billion people killed and affected by climate-related disasters worldwide from 2001 to 2010,[4] 89% were located in Southeast, Southern, and Eastern Asia (see Figure 1).[5]

When we take a more detailed look at country level patterns over the slightly longer time-period of 2000-2012, we see that the most populous countries—China and India—were the most affected by climate-related disasters. 60% of those affected were located in China with another 25% in India (see Figure 2). Floods were the main drivers, responsible for 51% of the total, followed by droughts (about 28%) and storms (at 17%). Single events often drove the size of the death totals—a 2002 drought in India that affected 300 million, and the 2003, 2007, and 2010 floods in China that each affected more than 100 million people. There is no clear trend in the number of people affected during this period.[6]

In terms of deaths, some 234,975 were killed by climate-related disasters during this time period. Of these, cyclone Nargis that struck Myanmar in 2008 claimed nearly 60% of the total. India (23,155), China (15,877), and the Philippines (13,937) followed with the next highest numbers of deaths.[7]

What effect will climate change have on the region, particularly with respect to exposure to climate-related hazards and extreme storms? Current data availability makes this a particularly difficult question to answer with geographic precision and high confidence.

Figure 2: Number of People Affected by Climate-Related Disasters, 2000 - 2012



The science of climate change attribution for extreme weather events is a young and contentious one. Studies on the future frequency and intensity of extreme weather events in Asia, namely cyclones, have not yet generated strong conclusions and confidence across models. Asia is a diverse and large region; thus the impacts are likely to vary significantly by location.

Nonetheless, the 2014 Fifth Assessment Report from the Intergovernmental Panel on Climate Change Working Group II drew some strong conclusions about likely impacts, emphasizing the exposure of coastal and riverine populations to flooding and storm surge, even in the absence of clear signals on cyclone risk. Moreover, the report concluded:

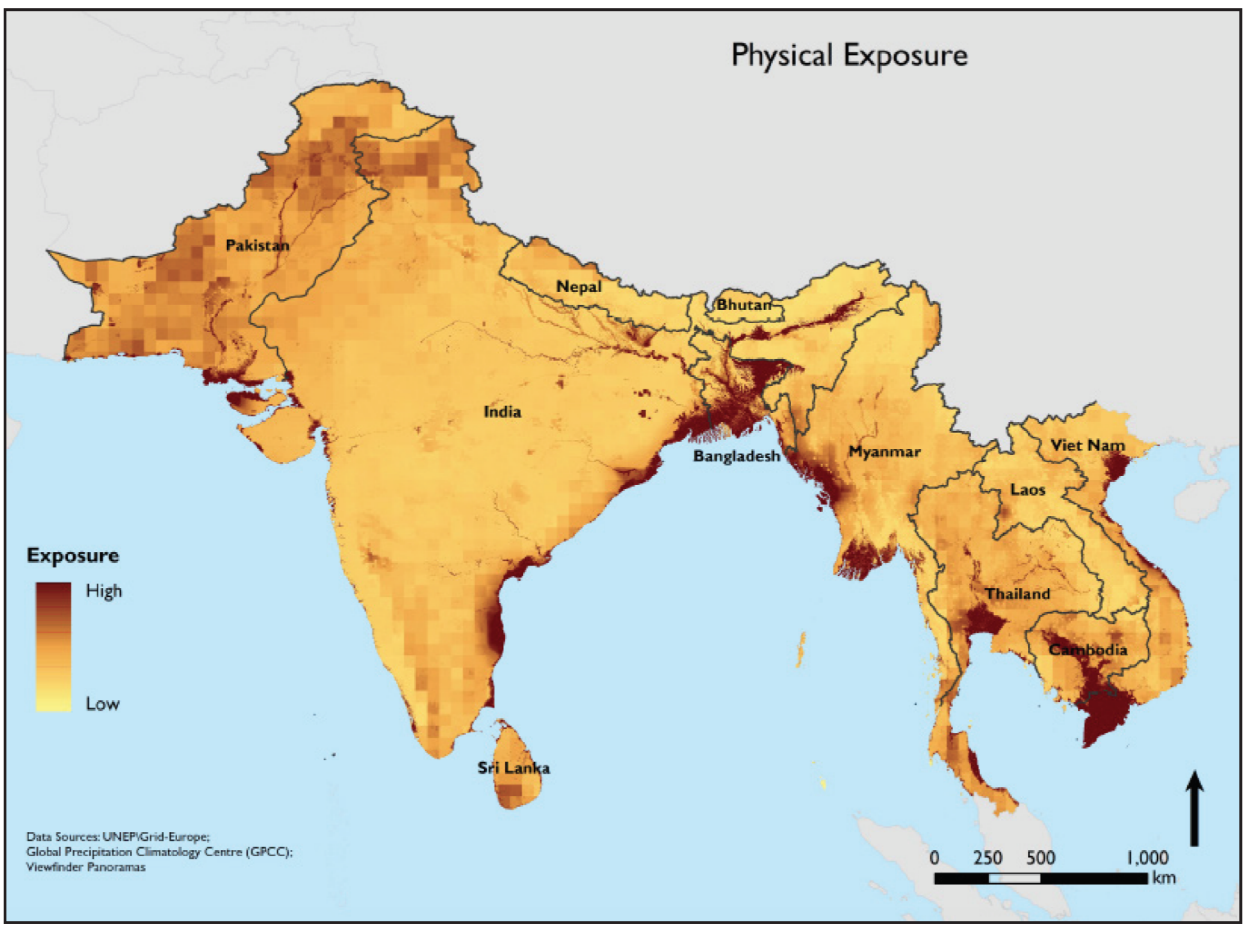
> Extreme climate events will have an increasing impact on human health, security, livelihoods, and poverty, with the type and magnitude of impact varying across Asia (high confidence) [24.4.6]. More frequent and intense heat-waves in Asia will increase mortality and morbidity in vulnerable groups. Increases in heavy rain and temperature will increase the risk of diarrheal diseases, dengue fever and malaria. Increases in floods and droughts will exacerbate rural poverty in parts of Asia due to negative impacts on the rice crop and resulting increases in food prices and the cost of living.[8]

Thus, though aspects of Asia's vulnerability to climate change remains uncertain, the region remains especially vulnerable, given large population concentrations, particularly along coasts and rivers. Where are these effects likely to be located?

Climate Security Vulnerability

In previous work on Africa, the research team developed a methodology for locating *climate security vulnerability* at the subnational level.[9] Climate security

Figure 3: Climate Related Hazard Exposure



vulnerability was defined as the risk in a particular location that large numbers of people could die from either direct exposure to a natural hazard or the follow-on consequences of dislocation and instability that the hazard might generate.

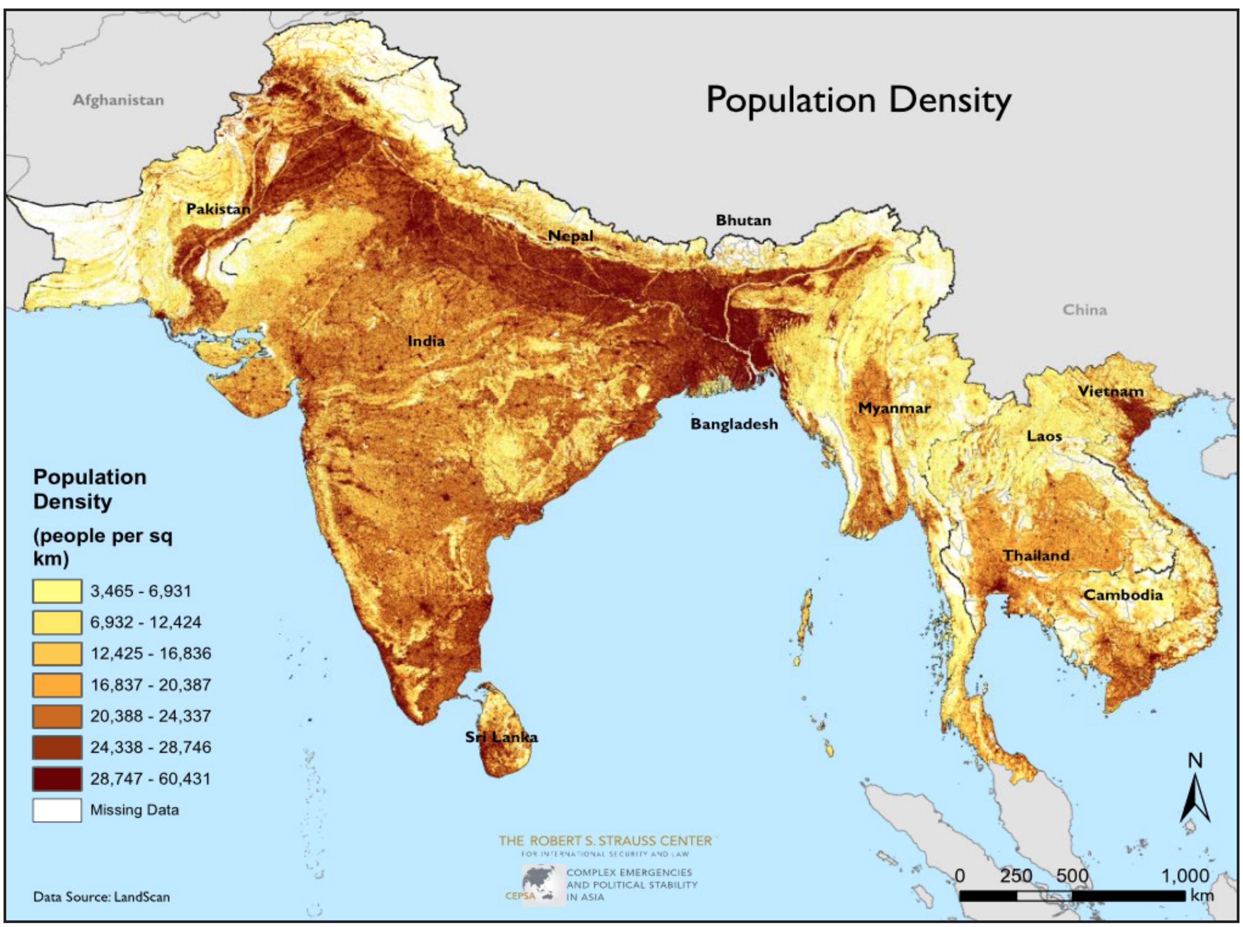
Vulnerability in this sense goes beyond mere *physical exposure*. For large numbers of people to die, an area exposed to a physical hazard has to have a large *population*. However, whether or not people are at risk of death depends in part on what resources they have to protect themselves at the *household and community level*. Finally, some natural hazards may exceed the capacity of communities to protect themselves so whether large numbers die will therefore depend on whether their *governments* are willing and able to protect them in times of need.

Methods

To measure climate security vulnerability, the team applied the CCAPS model for Africa to the Asian context. The CCAPS model views climate security vulnerability as a function of four baskets or processes: physical exposure, population density, household and community resilience, and governance. Each basket save for physical exposure is comprised of multiple indicators - six to eight per basket.[10] In the final composite basket, each basket is equally weighted. The team sought subnational indicators wherever possible. Indicators are available at finer resolution for physical exposure and population than household and governance indicators, which are either only available at the first administrative or national levels.

To create the index, the team developed a comprehensive map of subnational geographic units in the region, drawing from diverse information sources.[11] The team compiled data sources for each basket and indicator. Each indicator was normalized on a zero to 1 scale in terms of its percent rank. This allows us to capture the relative rank of a given geographic unit relative to

Figure 4: Population Density



the rest of the sub-region. The final composite index is also a measure of *relative regional vulnerability.* As a consequence, scores and rankings between Asia and Africa are not directly comparable.

Climate Related Hazard Exposure

The physical exposure basket includes historic indicators of climate-related hazard exposure including cyclones, floods, wildfires, and water anomalies. In addition, a digital elevation model captures areas at risk of coastal inundation from storm surge (see Table 1 in Appendix).[12] The patterns in Figure 3 show that low elevation coastal areas in Bangladesh and Myanmar are especially exposed to climate hazards. Cyclone risk coupled with low-elevation coastal zones radiates from Odissa and West Bengal states in India through Bangladesh to Rakhine State in Myanmar. Cyclone and low-elevation coastal zone exposure also extends to Andra Pradesh in southeastern India as well as Gujarat in northwestern India across the Sir Creek estuary to Sindh province in southwestern Pakistan. Exposure also follows major river systems such as the Indus through Pakistan, the Ganges through India, the Brahmaputra in Bangladesh, and the Mekong in Cambodia. Negative rainfall anomalies were concentrated in central and northern Pakistan, Sri Lanka, Thailand, Cambodia, and southern Vietnam with chronic water scarcity concentrated in Sindh province in Pakistan. Southeast Asia is the site of most wildfires in the region with pockets in southern Myanmar, Thailand, northern Laos and Vietnam, and eastern Cambodia.

Population

Unlike the other baskets, the population basket consists of a single population density layer generated with data from LandScan.[13] LandScan is a modeled dataset that seeks to measure "ambient" populations and is based on a variety of inputs such as road networks, elevation, slope, land use/land cover, and high resolution imagery.

Figure 5: Household and Community Resilience

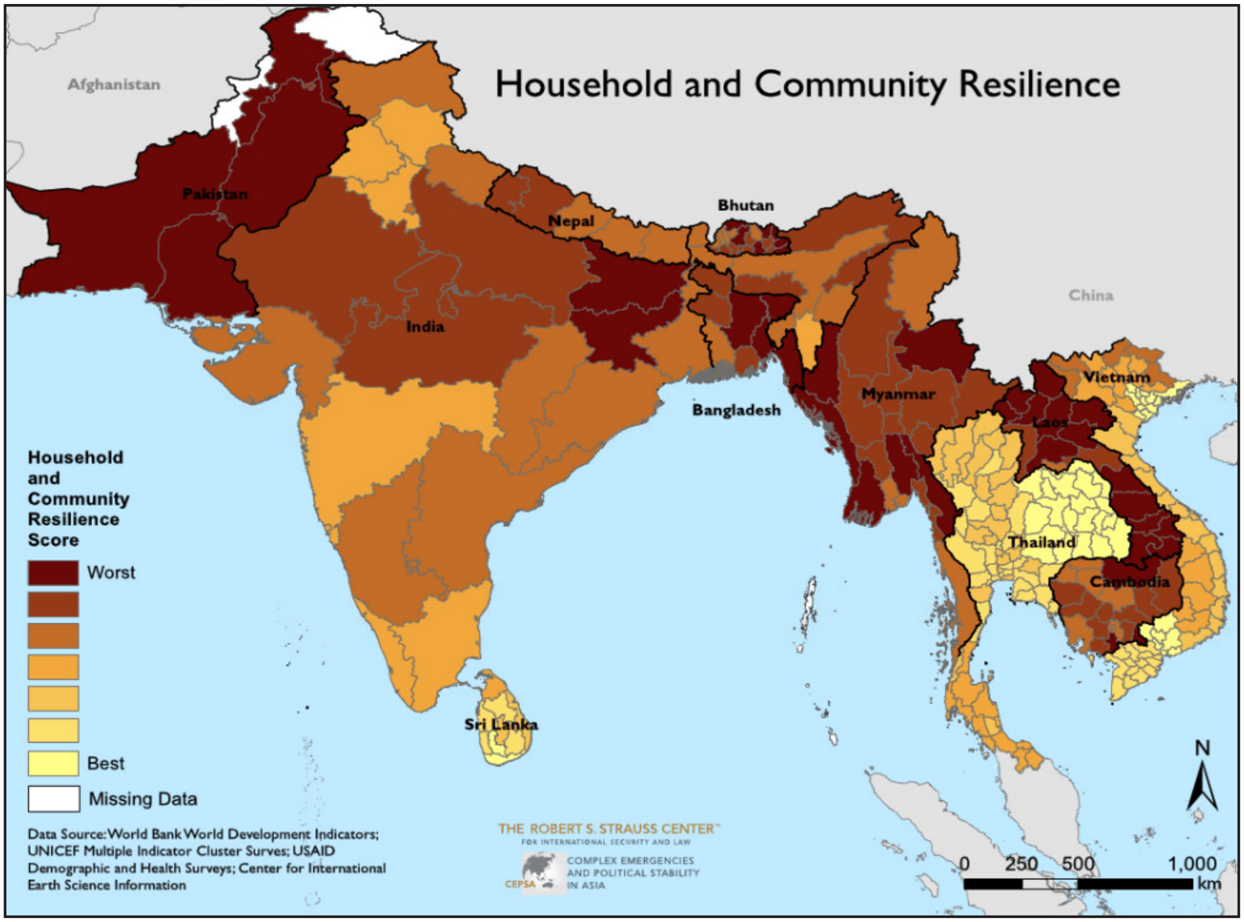


Figure 4 shows the relative population density in the region with South Asia much more densely populated than Southeast Asia. Densely populated areas extend across the Indo-Gangetic plain at the base of the Himalayas encompassing nearly all of Bangladesh across Eastern India (including West Bengal and the city of Calcutta) across to include the Indian states of Uttar Pradesh and Delhi and extending across the two Punjabs of western India and eastern Pakistan. Other high population areas include the Kerala, a coastal southwestern state of India as well as sites around major cities including Colombo in Sri Lanka, Hanoi (Vietnam), and Bangkok (Thailand).

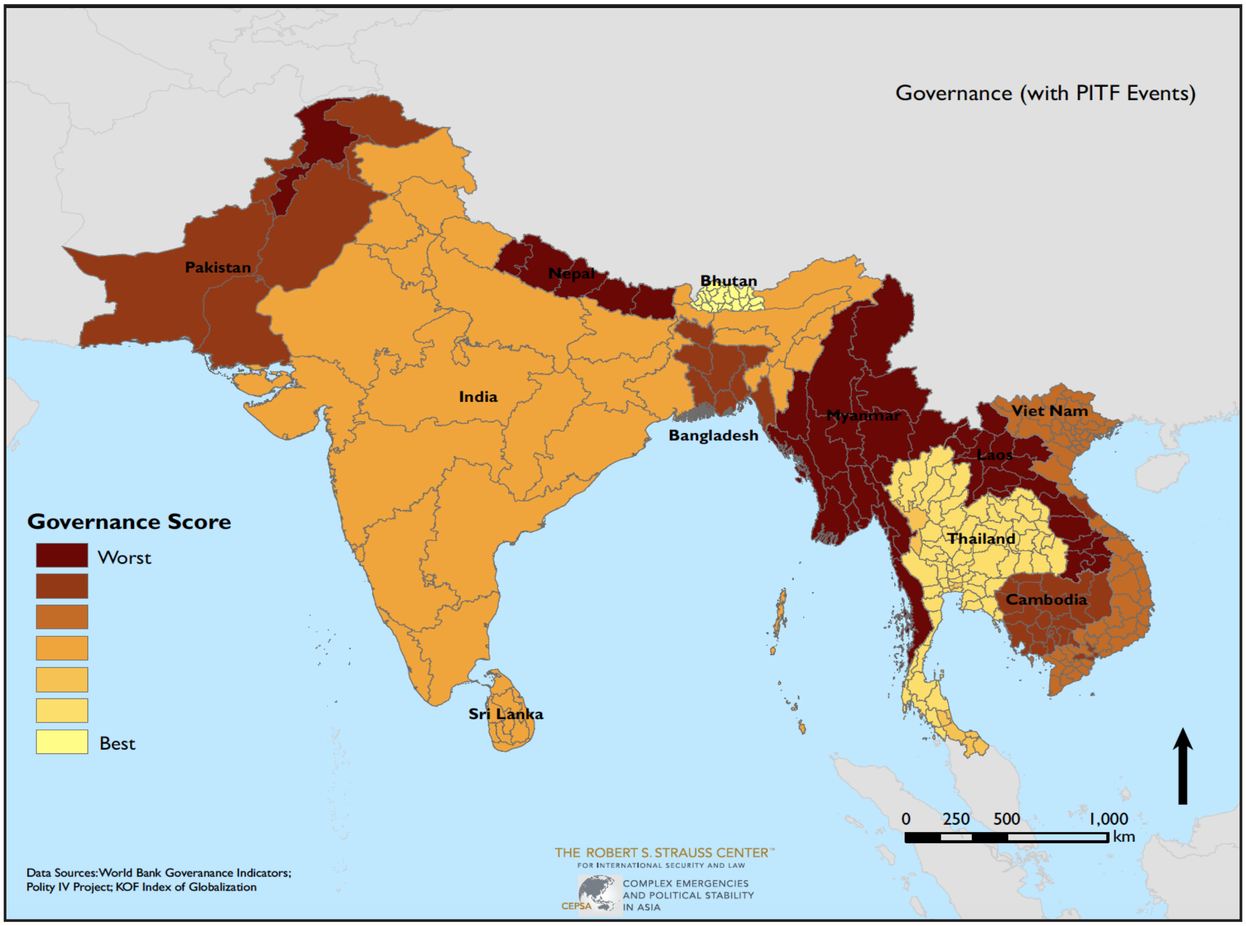
Household and Community Resilience

In the face of exposure to climate-related hazards, the first line of defense for communities and households is their resilience, reflected by their (1) levels of education, (2) quality of health, (3) access to health services and (4) access to daily necessities. All else equal, communities that are better educated, have better health conditions, and access to services are likely to fare better and recover faster in the event of exposure to natural hazards compared others with lower levels of achievement.

For each of these four sub-processes, the team identified two relevant indicators, splitting the weight between them or using one indicator if the other was unavailable (see Table 3 in Appendix). All but two of the eight indicators in this basket(number of nurses, life expectancy) are available at the subnational level. For many countries in the region, subnational information was available at the first administrative level from the USAID Demographic and Health Surveys or from the UNICEF Multiple Indicator Cluster Survey.

As shown in Figure 5, the team found that many areas of Pakistan, Laos, and Bhutan were among the least resilient in the region as well as several regions of

Figure 6: Governance



Myanmar (Ayeyarwady, Rakhine, Chin, Bago, Kayin State), two states in India (Bihar and Jharkhand), several regions of Bangladesh (Chittagong, Dhaka, and Sylhet), and one region of Cambodia (Preah Vihear/ Steung Treng provinces).

Governance

Natural hazards may exceed the coping capacities of local communities, thus requiring government mobilization to help them in times of need. The team drew from national-level indicators of government effectiveness, voice and accountability, two measures of political stability, and global integration to map regional governance measures. The only subnational measure in this basket is a measure of atrocities from the Political Instability Task Force (PITF) (see Table 4 in Appendix).[14]

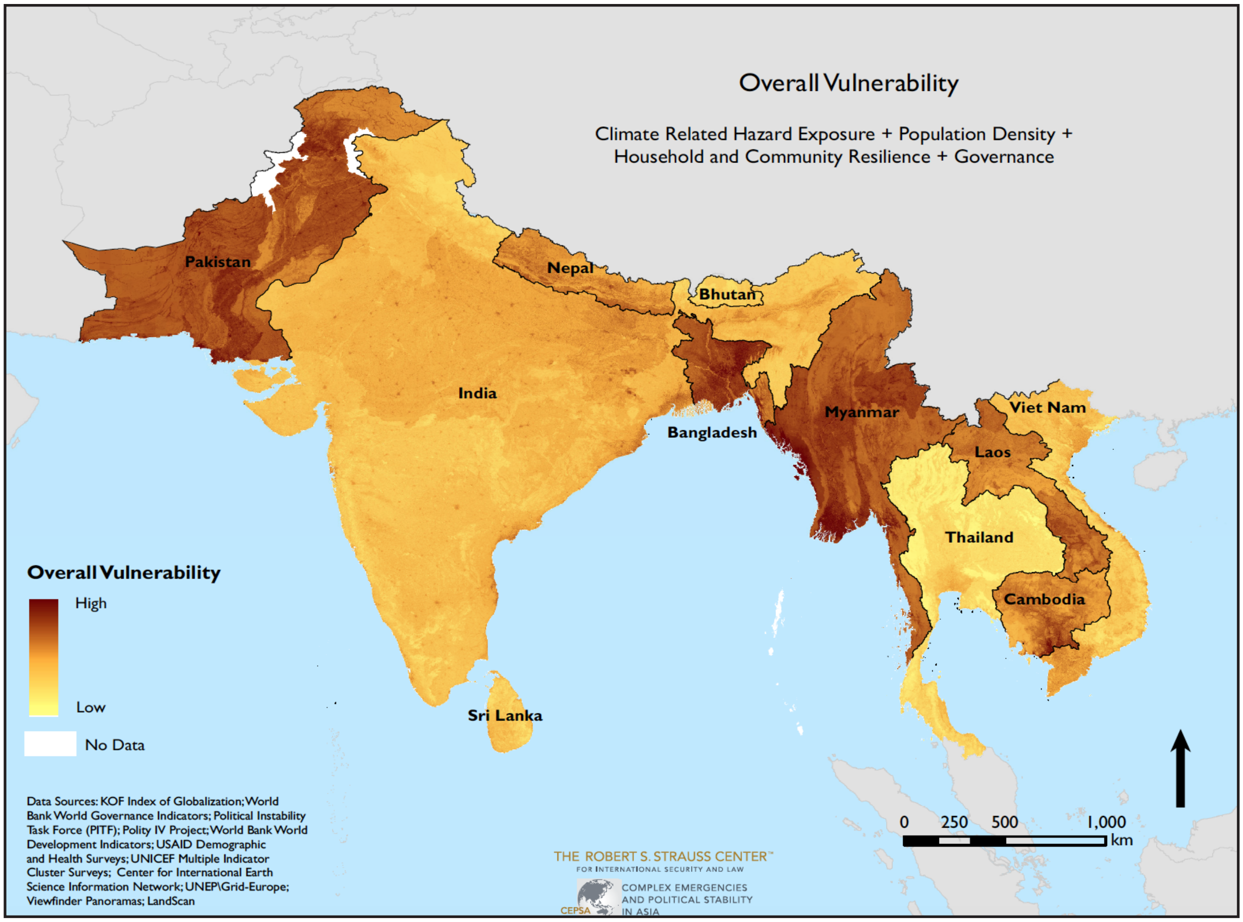
As Figure 6 shows, Myanmar, Laos, and Nepal had the worst governance in the region, followed by pockets in Pakistan (namely, in the northern part of Khyber Pakhtunkhwa). Thailand and Bhutan had comparatively better governance, though our indicators of political stability from Polity IV do not yet reflect the 2014 Thai coup. Subnational variation is driven by violent events from the Political Instability Task Force (PITF).

Composite Regional Vulnerability

Combining these four layers yields a composite map of relative vulnerability in the eleven countries of South and Southeast Asia. Initial findings suggest that much of Bangladesh (notably Dhaka), parts of southern Myanmar (the Ayeyarwady region), and parts of southern Pakistan (namely Sindh province) are the most vulnerable locations from a climate security perspective (see Figure 7).

One can see the sources of vulnerability at the subnational level through pullout maps for Pakistan, Myanmar, and Bangladesh. Pakistan's Sindh province

Figure 7: Composite Vulnerability

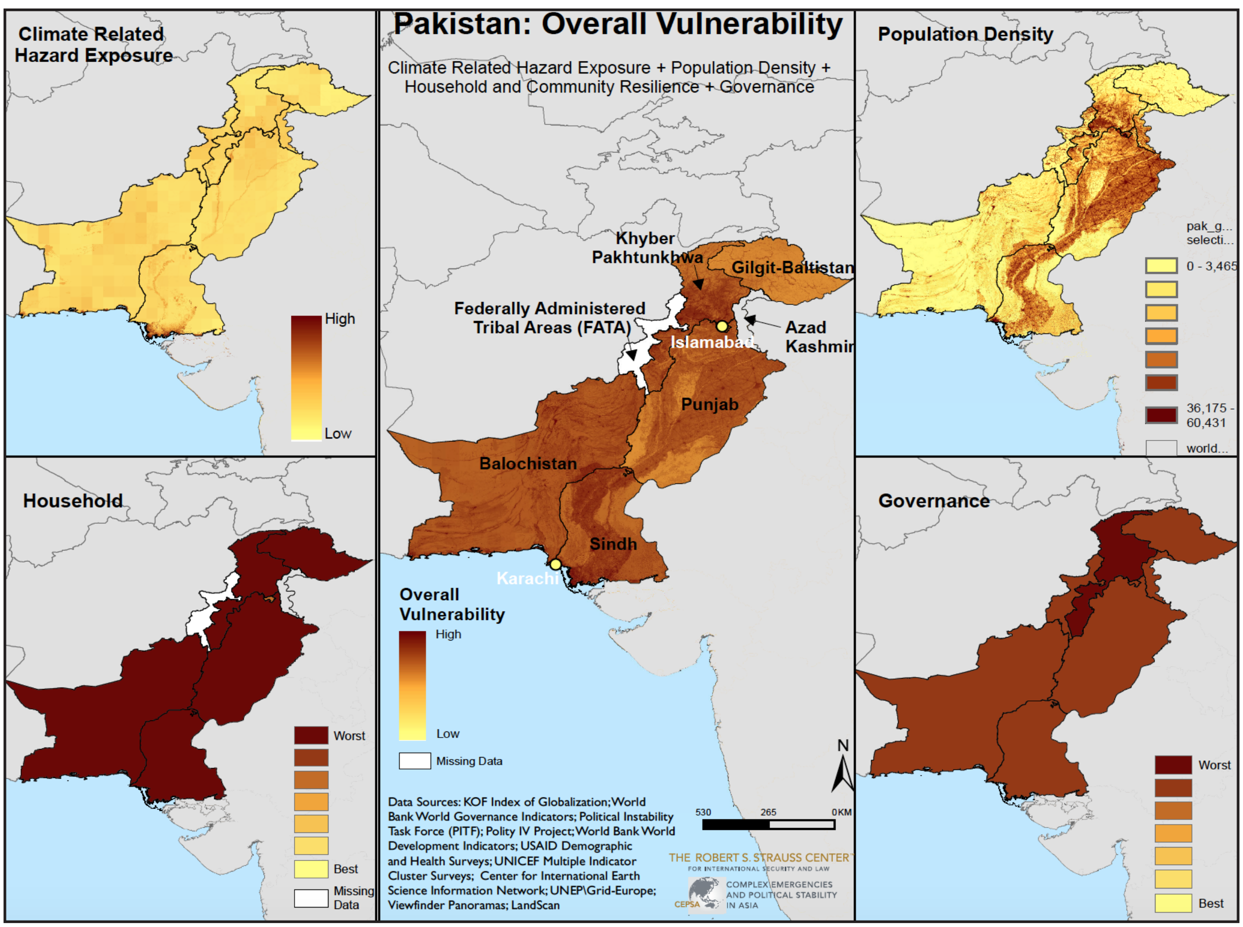


faces exposure to cyclones, sea-level inundation, and flooding. Home to Pakistan's largest city, Karachi, the province faces high infant mortality, low female literacy, low numbers of nurses per capita, low primary school attendance, and poor access to improved drinking water. Governance measures at the country level are poor, though not the worst in the region, but Khyber Pakhtunkhwa fares worse on governance given higher political violence in the PITF data (see Figure 8).

In Bangladesh, we can also begin to tell the story of Dhaka's specific confluence of vulnerability (see Figure 9). While much of the country is densely populated, the Dhaka division stands out from the rest, given low elevation and flooding along the Buriganga River. Moreover, the division faces high levels of child malnutrition, low numbers of nurses, low school attendance and mediocre scores for female literacy and births in a healthcare facility. Though not as problematic as other countries in the region such as Myanmar, Bangladesh's governance scores across all regions are not particularly good.

Finally, Myanmar's troubled history of governance and physical exposure to climate hazards creates challenges for Rakhine State and the Ayeryarwady region (see Figure 10). As noted above, the densely populated Irawaddy Delta was already subject to one of the worst disasters in the region when cyclone Nargis struck in 2008. Both Ayeryarwady and Rakhine are subject to cyclone and low-elevation zones, with Rakhine also subject to a history of wildfires. While subnational household metrics are not available for all indicators, for those for which information is available, Rakhine State has very low scores compared to other areas within Myanmar and relative to the wider region, namely school attendance, access to drinking water, and malnutrition. Myanmar's overall national governance scores are by and large near the bottom for the entire region. While the governance changes have ushered in prospects for democratic reform, the country is now buffeted by divisive religious violence and the

Figure 8: Climate Security Vulnerability in Pakistan



challenges many post-authoritarian governments face in putting a lid on violence.

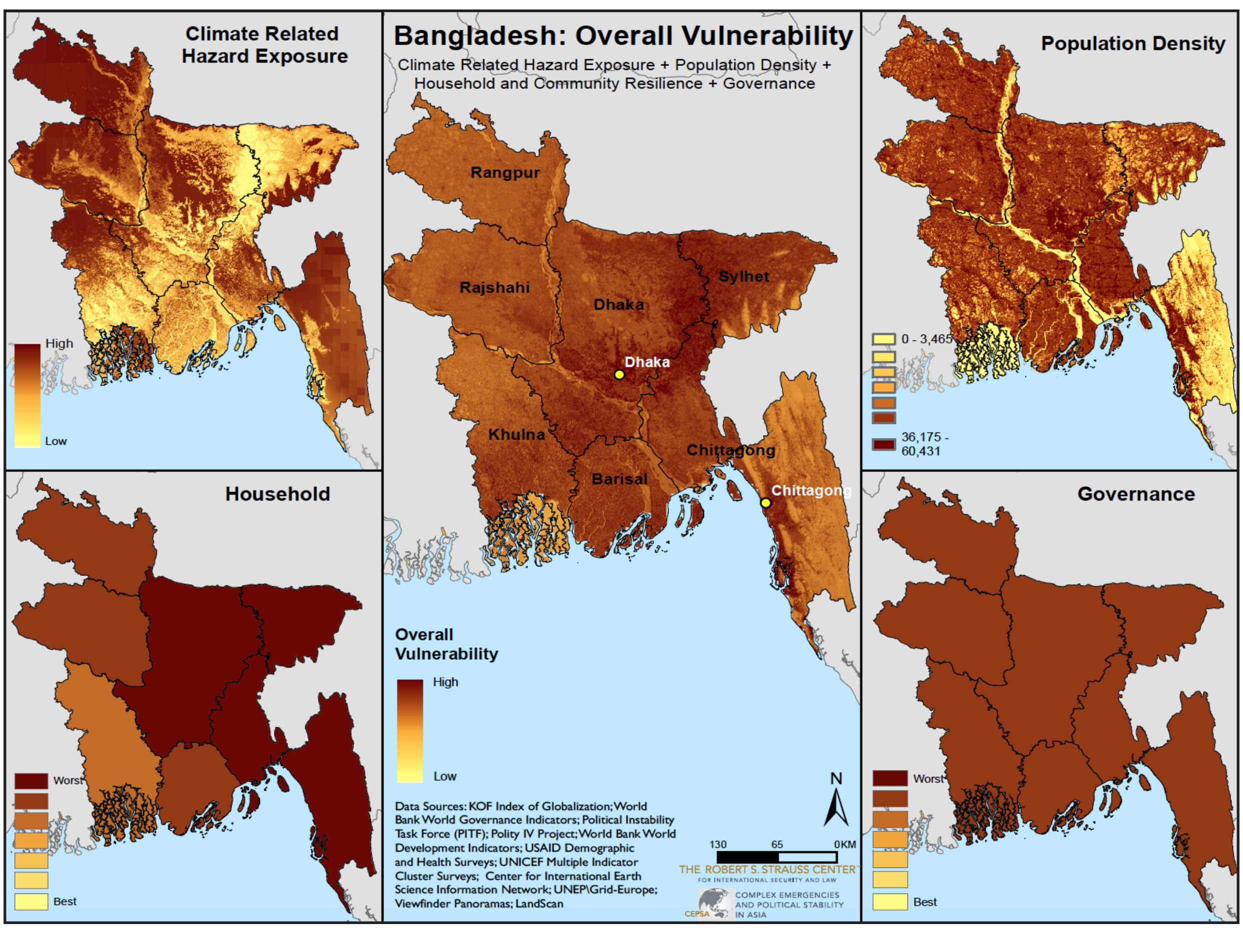
Next Steps

This is the first of several iterations of CEPSA's Asian Climate Security Vulnerability model (ACSV 1.0). The team intends to refine the index to take in to account more local factors and indicators where appropriate and available. For example, in light of the heatwave events of summer 2015 that claimed thousands of lives in Pakistan, the team anticipates including heat wave events in subsequent refinements of the model.

In addition, we know that land degradation likely makes the effects of extreme weather events much worse. For example, Chennai, a relatively wealthy coastal city in southeastern India, in November and December 2015 endured devastating floods that left much of the city underwater. As many commentators noted, this was a man-made disaster as the city (and other cities throughout the region) has experienced significant conversion of mangroves to urban infrastructure as the city has grown. Much urban development, including universities, roads, housing complexes and airports, across the region is being built on flood plains without sufficient regard for drainage and hazard exposure. Peri-urban areas with slum development area also often constructed on marginal areas subject to coastal inundation, flooding, and erosion.[15]

Therefore, we believe a measure of land degradation would be important to incorporate in to our physical exposure basket to capture this dimension. We are partnering with geographers from the University of Oklahoma to apply a new disturbance index (DI) to the region. The disturbance index uses remote sensing data to capture different dimensions of the light spectrum that match brightness, greenness, and wetness. While an existing measure, the Normalized Vegetation Difference Index (NVDI), already incorporates greenness, the disturbance index is potentially better able to capture

Figure 9: Climate Security Vulnerability in Bangladesh



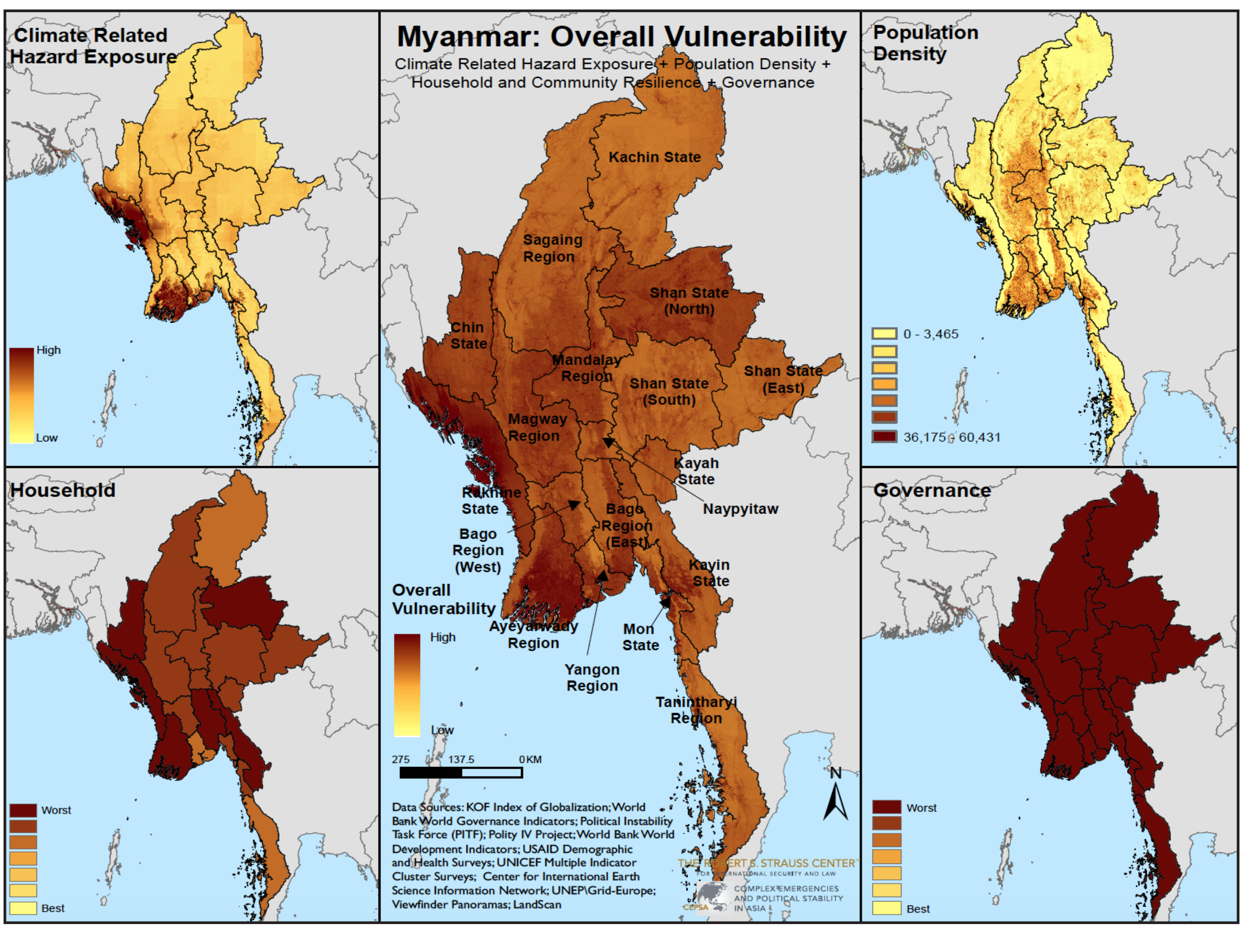
urban infrastructure through the incorporation of the other dimensions. The disturbance index can show changes in land cover in both rural and urban areas, reflecting deforestation as well as conversion from agriculture to buildings and impervious surfaces.[16]

Another area of interest is how to capture national level vulnerability for countries such as India that had relatively undifferentiated vulnerability when compared to the wider region. India, despite high population density and pockets of physical exposure, is the least vulnerable to climate change in the region and the country has relatively undifferentiated vulnerability. These patterns are in part driven by national-level indicators that are the main components of the governance index. The results do not change much even when we subdivide the index in to separate assessments for South Asia and Southeast Asia yielded similar results to the combined composite.[17]

To capture internal variation within India, the team may re-scale all indicators to create an India-specific map that assesses Indian states relative to other areas in India. Moreover, India possesses considerable variation in subnational state-level governance quality. However, subnational metrics of government effectiveness are not readily available for all countries, though potential indicators of subnational governance for India are. The team will also experiment with governance indicators that include more subnational governance metrics in the India-only vulnerability maps.

Beyond these refinements, going forward, subject matter and regional experts will be asked to review the models and methods presented here, including indicator inclusion, model weights, the functional form of the index, and other parameters.[18] Those survey results will inform potential amendments to the model and sensitivity tests that could be applied to subsequent iterations of the model. Other refinements and extensions might include a combined subnational regional vulnerability index for Africa and

Figure 10: Climate Security Vulnerability in Myanmar



Asia, which would allow us to compare vulnerability between regions. In addition, there may be scope for triangulation with projections of future climate change based on climate models, as the CCAPS team carried out for Africa.[19]

Finally, the team acknowledges that the maps are models meant to capture and reflect an underlying, more complex reality. To be useful, maps require interpretation and refinement in an iterative conversation with regional experts. This brief is the beginning of that process of dialogue and revision.

Appendix

Table 1: Indicators Used to Assess Physical Exposure to Climate-Related Hazards				
Hazard Type (weight)	**Indicator**	**Scale**	**Years of Data Used**	**Source**
Cyclones (20%)	Tropical cyclones average sum of windspeed (km per year)	2 km x 2 km resolution	1970-2009	UNEP/GRID-Europe
Floods (20%)	Floods per 100 years	1 km x 1 km resolution	1999-2007	UNEP/GRID-Europe
Wildfires (20%)	Frequency of wildfires	1 km x 1 km resolution	1995-2011	UNEP/GRID-Europe
Rainfall Anomalies (10%)	Number of months between 1980-2009 in which the 6-month accumulated rainfall was 1.5 standard deviations or more below the average for that caelndar month over the previous 20 years	0.5 degree	1981-2009	Global Precipitation Climatology Centre
Chronic Water Scarcity (10%)	Monthly coefficient of variation	0.5 degree	1981-2009	Global Precipitation Climatology Centre
Coastal Inundation (20%)	Low-lying coastal areas within 0 to 10km above sea level	90m x 90m resolution		Viewfinders Panorama

Table 2: Indicatiors Used to Assess Popluation Density				
Variable	**Indicator**	**Scale**	**Years of Data Used**	**Source**
Population Density	Ambient population (average over 24 hours)	1 km x 1 km resolution	2013	LandScan, Oak Ridge, National Laboratory

Table 3: Indicators Used to Assess Household and Community Resilience				
Category (weight)	**Indicator (weight)**	**Scale**	**Years of Data Used**	**Source**
Education (25%)	Literacy rate, female (% of people ages 15-24) (12.5%)	National, CEPSA First Administrative District	DHS 2005, 2006, 2010, 2011, 2013; MICS 2010-2012; WDI 2011-2013	Subnational data from USAID Demographic and Health Surveys (DHS) snf UNICEF Multiple Indicator Cluster Survey (MICS); national data from World Bank World Development Indicators (WDI)
	School attendance, primary (% gross) (12.5%)	National, CEPSA First Administrative District	DHS 2005, 2006, 2010, 2011, 2013; MICS 2010-2012; WDI 2011-2013	Subnational data from DHS, MICS; national level data WDI
Health (25%)	Infant mortality rate adjust to national 2000 UNICEF rate (12.5%)	CEPSA First Administrative District	2008	Center for International Earth Science Information
Daily Necessities (25%)	Percentage of children underweight (more than two standard deviations below the mean weight-for-age score of the NCHS/ CDC/WHO	National, CEPSA First Administrative District	DHS 2005, 2006, 2010, 2011, 2013; MICS 2010-2012; WDI 2011-2013	Subnational data from DHS, MICS; national data WDI
	Population with sustainable access to improved drinking water sources total (%) (12/5%)	National, CEPSA First Administrative District	DHS 2005, 2006, 2010, 2011, 2013; MICS 2010-2012; WDI 2011-2013	Subnational data from DHS, MICS; national data WDI
Access to Healthcare (25%)	Health expenditure per capita (current US$) (12.5%)	National	WDI 2004, 2010, 2011, 2012	WDI
	Delivery in a healthcare facility (% of births) (12.5%)	National, CEPSA First Administrative District	DHS 2005, 2006, 2010, 2011, 2013; MICS 2010-2012; WDI 2011-2013	Subnational data from DHS, MICS; national data WDI

Table 4: Indicators Used to Assess Governance and Political Violence				
Category (weight)	**Indicator (weight)**	**Scale**	**Years of Data Used**	**Source**
Government Responsiveness (20%)	Voice and Accountability	National	2009, 2010, 2011, 2012, 2013	WDI
Government Response Capacity (20%)	Government Effectiveness (20%)	National	2009, 2010, 2011, 2012, 2013	WDI
Openness to External Assistance (20%)	Globalization Index (20%)	National	2011	KOF Index of Globalization
Political Stability (20%)	Polity Variance (10%)	National	2005-2014	Polity IV Project
	Number of Stable Years (as of 2014) (10%)	National	1950-2014	Polity IV Project
Political Violence (20%)	Subnational Events (20%)	CEPSA First Administrative Division	1999-2014	Political Instability Task Force (PITF)

Endnotes

[1] A longer academic article with a full description of the methods is available on the CEPSA website. See https://www.strausscenter.org/cepsa/.

[2] IPCC, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.* A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, eds. C. B. Field et al. (Cambridge: Cambridge University Press, 2012).

[3] Wendell Cox, "World Urban Areas Population and Density: A 2012 Update," *New Geography* May 3, 2012, www.newgeography.com/content/002808-world-urban-areas-population-and-density-a-2012-update.

[4] This estimate comes from the EM-DAT International Disaster Database. Climate-related disasters include storms, floods, wet mass movements, extreme temperatures, droughts, and wildfires. The average was 222 million a year over this time period. Centre For Research on the Epidemiology of Disasters (CRED), "EM-DAT: The OFDA/CRED International Disaster Database" (Brussels, Belgium: Université catholique de Louvain, 2012), www.emdat.be.

[5] In this statistic, Southern Asia encompasses Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, and Sri Lanka. Southeast Asia includes Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, and Vietnam. Eastern Asia thus encompasses China, Hong Kong, Macao, North Korea, Japan, Mongolia, and South Korea. United Nations Statistics Division, http://unstats.un.org/unsd/methods/m49/m49regin.htm.

[6] CRED (Centre For Research on the Epidemiology of Disasters), "EM-DAT: The OFDA/CRED International Disaster Database" (Brussels, Belgium: Université catholique de Louvain, 2014).

[7] Ibid.

[8] Y. Hijioka et a., "Asia," in *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, eds.* V.R. Barros et al. (Cambridge: Cambridge University Press, 2014): 1327-1370.

[9] Joshua W. Busby, Todd G. Smith, and Nisha Krishnan, "Climate Security Vulnerability in Africa Mapping 3.0," *Political Geography*, Special Issue: Climate Change and Conflict, 43 (November 2014): 51–67; Joshua W. Busby et al., "Climate Change and Insecurity: Mapping Vulnerability in Africa," I*nternational Security* 37, 4 (2013): 132–72; Joshua W. Busby et al., "Identifying Hot Spots of Security Vulnerability Associated with Climate Change in Africa," *Climatic Change* 124, 4 (2014): 717–31.

[10] The underlying maps for individual indicators are available on the CEPSA website.

[11] These include the Global Administrative Areas (GADM) and the USAID Demographic and Health Surveys (DHS).

[12] Except for water anomalies, which is comprised of two equally weighted indicators (of negative rainfall deviations and chronic water scarcity), all the indicators in this basket are equally weighted.

[13] This product was made utilizing the LandScan (2013)™ 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. The United States Government has certain rights in this Data Set. Neither UT-Battelle, LLC, nor the United States Department of Energy, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of the dataset. LandScan, 2013.

[14] The team has also experimented with conflict data from data on atrocities from the Armed Conflict and Location Event Database, which has been extended to cover this region and for which conflict event data is currently available from January 2015 onwards. Please contact the team for results.

[15] Aaron Pereira, "Chennai Floods: Decoding the City's Worst Rains in 100 Years," *India Express*, December 4, 2015, http://reverb.guru/view/522178920832932031.

[16] Kirsten M. de Beurs, Braden C. Owsley, and Jason P. Julian, "Disturbance Analyses of Forests and Grasslands with MODIS and Landsat in New Zealand," *International Journal of Applied Earth Observation and Geoinformation* 45, Part A (March 2016): 42–54.

[17] Please contact the authors for the details and maps.

[18] If you wish to be part of the review process, please contact the authors.

[19] Busby et al., "Identifying Hot Spots of Security Vulnerability Associated with Climate Change in Africa."

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