Climate Risk Zones: Predicting Migration Outflows in Southeast Asia

Introduction

The world has largely united around the issue of reducing the severity of climate change in the coming decades. The threat of sea-level rise (SLR) and more frequent and dramatic climate events such as monsoons and drought has inspired countries to enact policies reducing carbon emissions and sign supranational agreements such as the Paris Climate Accord . Despite these efforts, global carbon emissions actually increased by 2% by the end of 2017.[1] The harmful effects of climate change will not yet be mitigated, so the world should prepare for more significant SLR and droughts. Researchers have predicted that climate change will lead to migration outflows from affected regions as a reaction to inundated lands and crop failures.[2] Those migration outflows may in turn incite conflict between competing ethnic or political groups.[3]

This project is an effort to predict from where these population movements may originate with regard to Southeast Asia. This region was chosen in particular because of its vulnerability to SLR and its instability: many of the countries in this region are ethnically fractionalized and numerous ethnic conflicts are currently being fought in these states. I will predict these climate risk zones based on SLR, areas of low precipitation, and drought indices and analyze the potential outmigration in relation to the governance indices of the relevant countries: measures of political rights and government stability. Are these zones concentrated in any specific countries, and if so, could those states' regime contexts lead to friction and violence?

Methodology

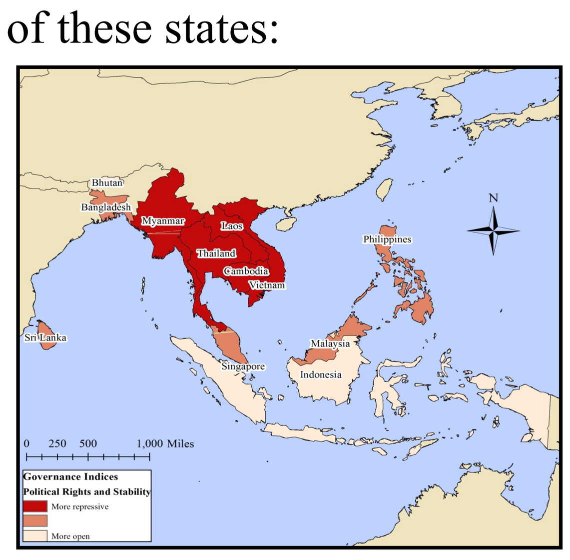
For this research, I used country and continent polygons from Esri; a 3 feet sea-level inundation raster from the Center for Remote Sensing of Ice Sheets; a Palmer Drought Severity Index (PDSI) raster with data from 1850 to 2014 from the National Center for Atmospheric Research; and a precipitation raster with data from 1978 to 2014 from NOAA . I also referenced a dataset on farming areas and seasons by Goethe University faculty, a political rights index by Freedom House, and a government instability index by the Economist Intelligence Unit.

To determine average precipitation during a broad range of agricultural seasons I exported precipitation data during June and November over a 10 year period to new layers and used raster calculator for both months. I repeated this step for PDSI. using the same time-frame. I used the Euclidean distance tool on the inundation layer to determine the areas closest and furthest from SLR. I reclassified each of these new layers from one to five, with the former denoting "safe" areas and the latter areas of climate risk: inundation or drought.

I created a layer illustrating climate risk zones by adding reclassified precipitation, PDSI, and inundation layers in raster calculator. I repeated this with a 50% weighting for SLR and 25% weighting for both precipitation and PDSI. Various pixels were blank because the original PDSI data lacked complete global coverage. I interpolated these data to estimate these missing areas and used kernel density for easier visual interpretation of the maps.

Conclusions

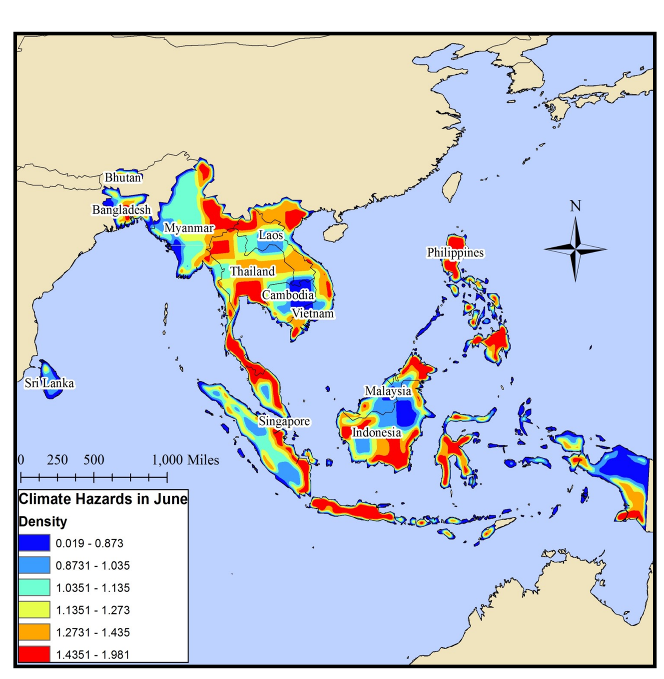
Myanmar, Laos, Thailand, Cambodia, and Vietnam, which all lie within two broad agricultural seasons, are of special interest in this analysis. Their main crops grow in blocks around June and November and these areas have experienced proportionally less precipitation than in neighboring countries. This region has a fairly pronounced climate vulnerability as indicated in the accompanying figures to the right. This is even more alarming when considering the repressive political atmosphere of these states:

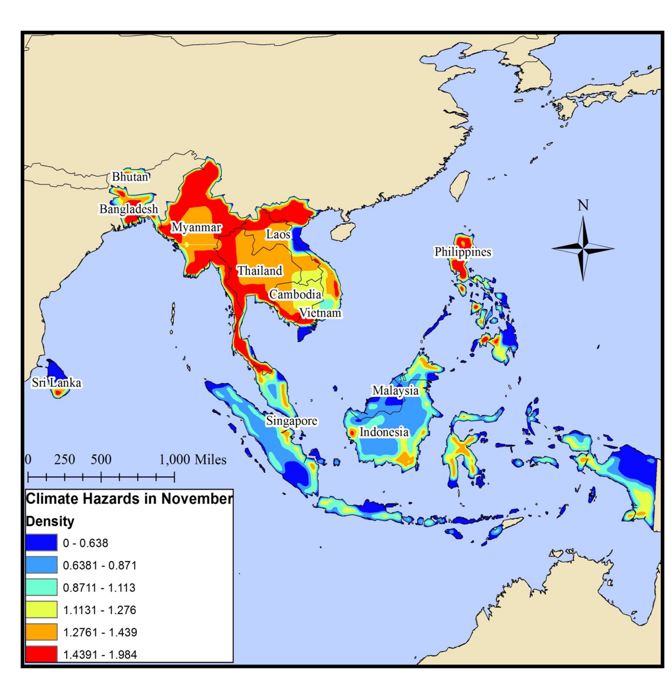


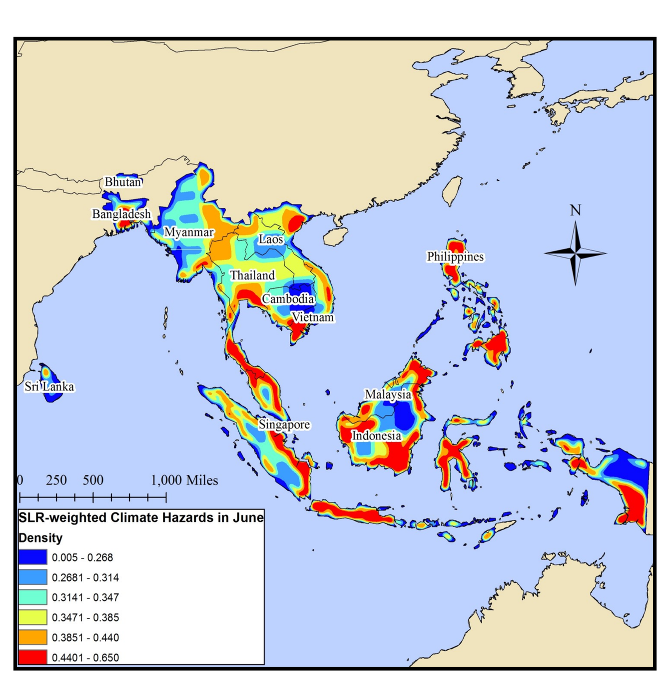
This shows a composite score derived from political rights and regime stability indices and suggests that these climate refugees may face persecution from repressive governments as they compete with other groups for land and resources. Many of the risk zones are populated by oppressed ethnic minorities, who may become more desperate when faced with a dwindling supply of food and water after their land becomes uninhabitable. Though vulnerable to SLR, Indonesia presents a less fragile environment. Although home to hundreds of ethnic groups, the country has been able to avoid major intra-state strife. Its governance index also suggests that violence is not on the horizon. The risk of ethnic violence resulting from migration and ethnic fractionalization, though not completely unthinkable, is low. Regarding my initial spatial question, climate risk zones do appear to be consistent through the agricultural season around Myanmar, Thailand, Vietnam, Malaysia, the Philippines, and parts of Indonesia. Ethnic conflicts in Southeast Asia such as with the Rohingya in Myanmar and Patani Muslims in South Thailand may become even more deadly as a result. More frequent crop failures can be expected, so many of these conflicts might evolve into resource wars alongside the ethnic friction. International organizations should ensure that marginalized ethnic groups and other communities of concern are secure before major climate events occur, so as to avoid potential mass-violence between these people and the communities into which they migrate.

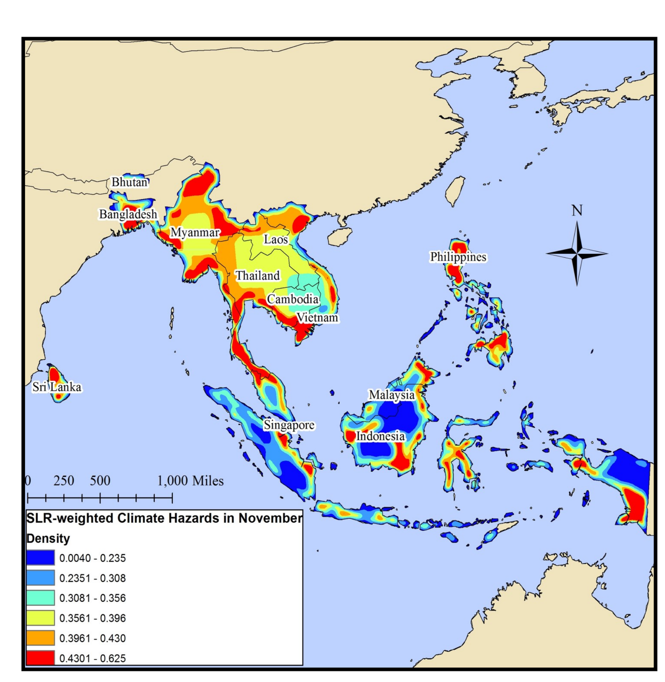
The general hazard climate suggested by these data is important to consider, but this research was not without limitations. Some areas of the above climate hazard density maps may be overemphasized due to the large size of the precipitation and PDSI rasters; one pixel could cover all of Cambodia. Additionally, the data is not completely up to date. A lag of four years may not seem significant for such large-scale data, but recent trends in the environment such as the 2% increase in atmospheric carbon in 2017 could have altered the results. The data might also be under- or overstated because of this.

Regions Vulnerable to Climate Change

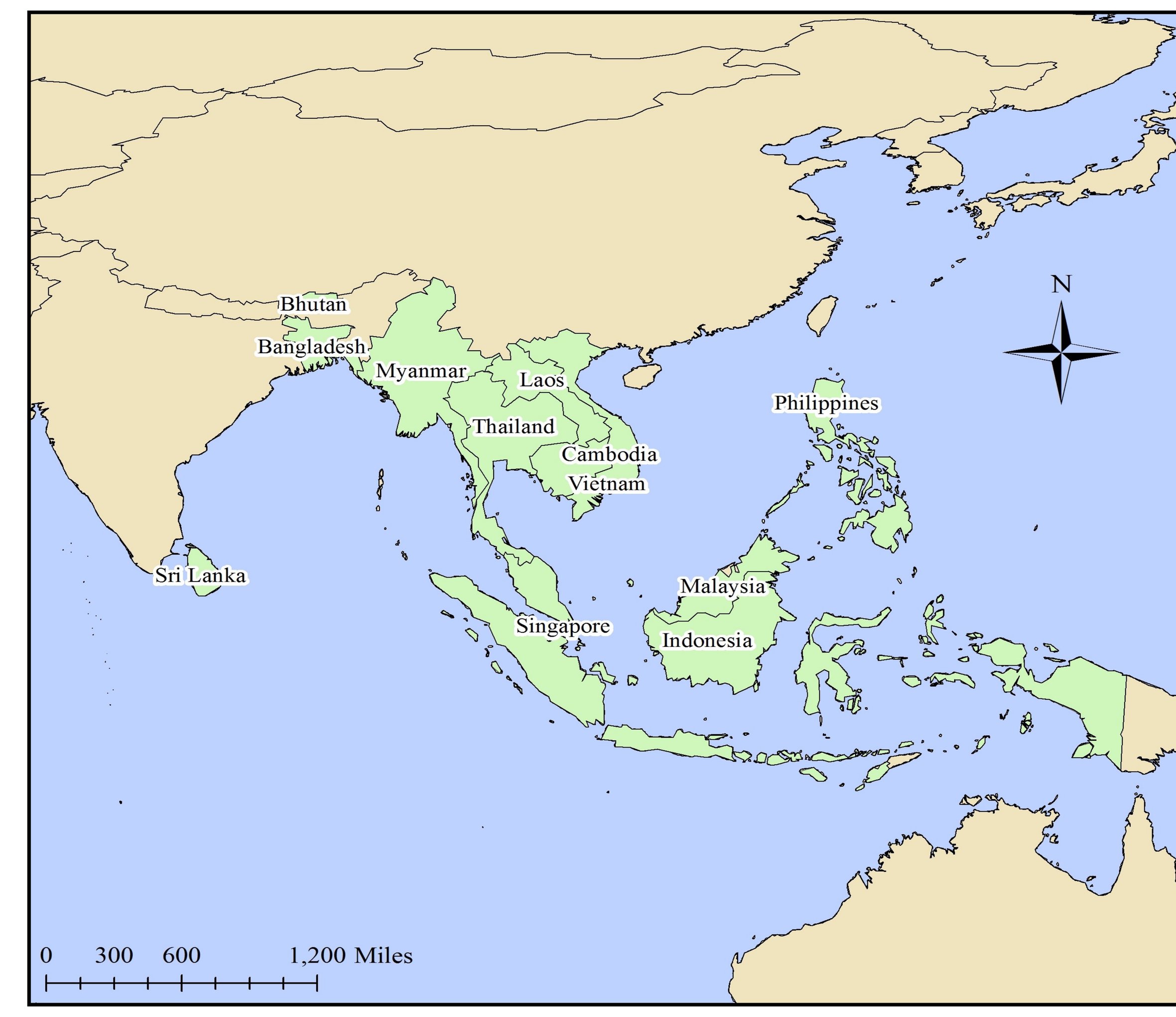








Area of Interest

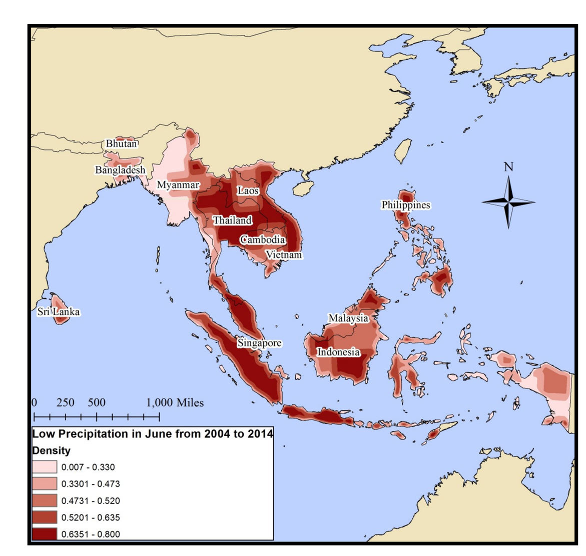


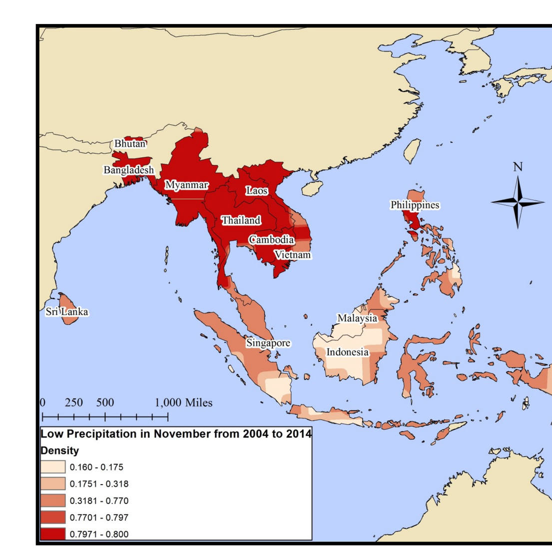
Coordinate System: GCS WGS 1984

Projection: Asia South Albers Equal Area Conic

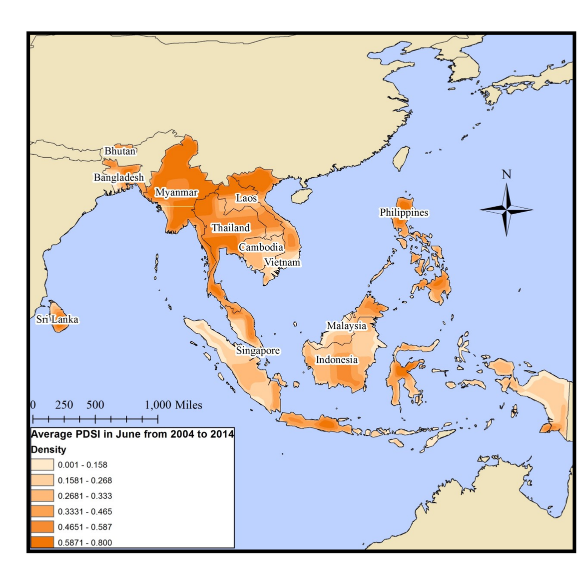
Regions Lacking Water Resources

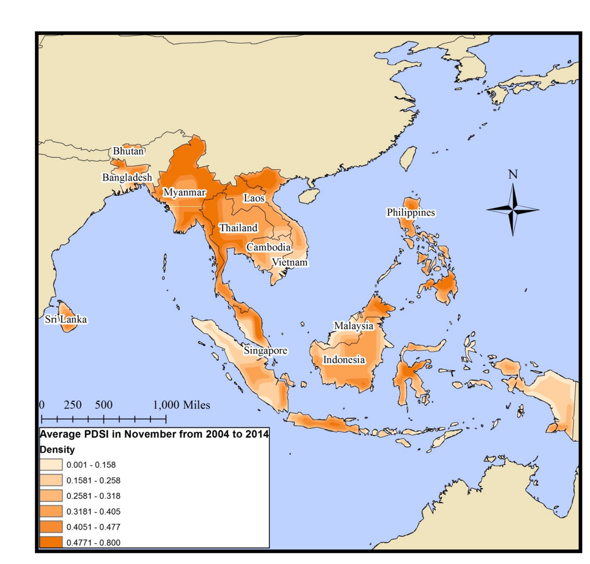
Precipitation over Time



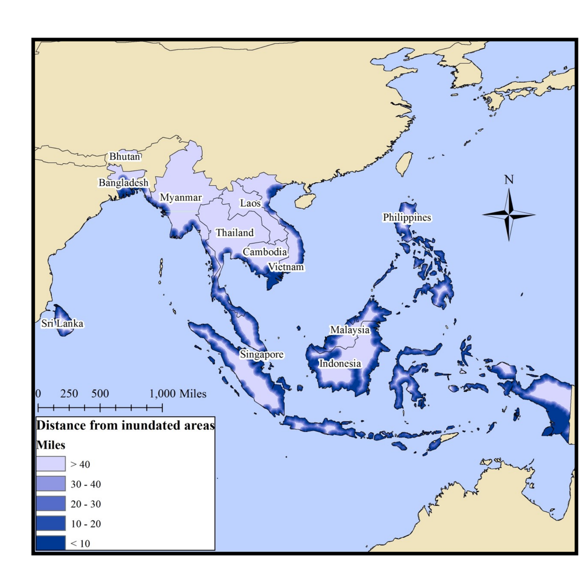


Drought Severity over Time





Inundation Relevance



Cartographer

Kevin Sung

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References

Esri, Center for Remote Sensing of Ice Sheets, National Center for Atmospheric Research, NOAA, Goethe University Frankfurt, Freedom House, The Economist Intelligence Unit.

[1] Plumer, Brad and Nadja Popovich. "CO_2 Emissions Were Flat for Three Years. Now They're Rising Again." *The New York Times* (New York, NY), Nov. 13, 2017.

[2] Folami, Olakunle Michael and Adejoke Olubimpe Folami. "Climate Change and Inter-Ethnic Conflict in Nigeria." *Peace Review* 25, no. 1 (2013): 104-110.

[3] Schleussner, Carl-Friedrich, Johnathan F. Donges, Reik V. Donner, and Hans Joachim Schnellhuber. "Armed-conflict risks enhanced by climate-related disasters in ethnically fractionalized countries." *PNAS* 113, no. 33 (2016): 9216-9221.