Monsoons in India: Risk and Vulnerability of Farmers

Introduction

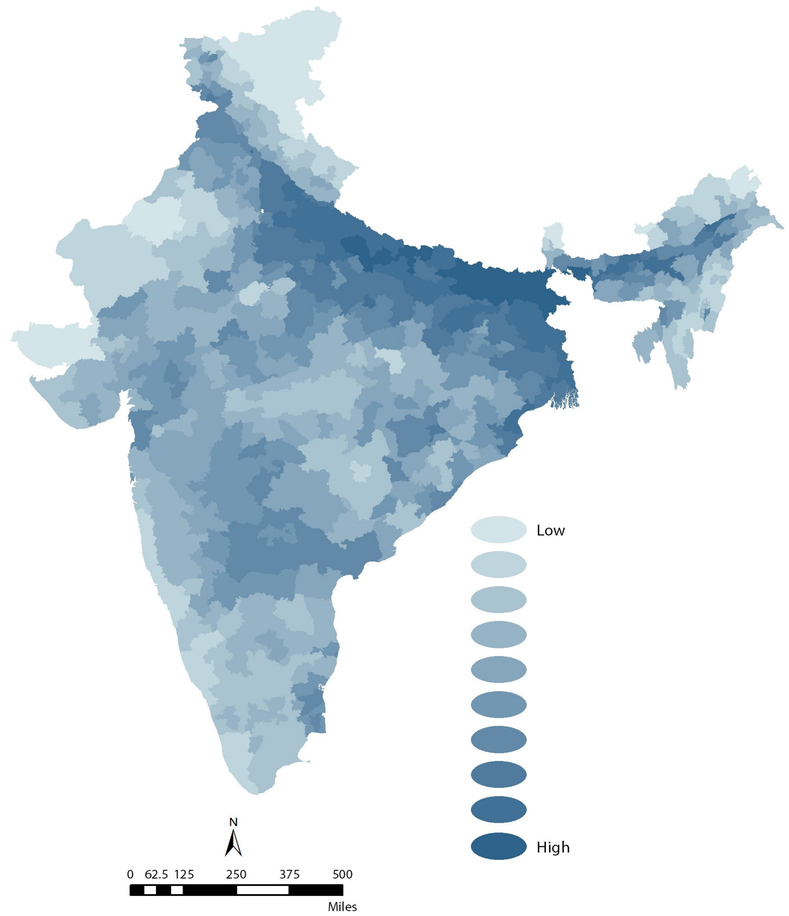
Since 2000, India has seen tremendous economic growth that is having strong, positive impacts at every level of society. While India lags China economically, India is still the world's largest democracy and rising power. However, while its recent growth is positive, India also contains the most exposed population to natural hazards, in particular its people are subject to the monsoon season. The government has not scaled its disaster preparedness services in line with its growth. Therefore, unexpected variation of the monsoon season represents a significant threat to the continued growth of the economy, in particular to rural farmers.

There are two key related spatial questions that motivate the following analysis:

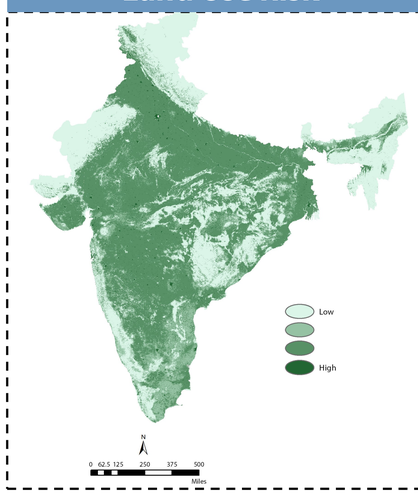
1. Where are the most monsoon-prone areas of India?
2. In order to maximize the impact of disaster relief services, which of those areas contain highest priorities of those who are most vulnerable?

The following analysis will combine socioeconomic vulnerability with physical risk and land use risk to determine the areas in India most vulnerable to extreme monsoon events. In this case, extreme can either mean too much or too little rain from monsoon, since each extreme has its own negative implications for people. Rural farmers are still a high proportion of the population in India and therefore particularly relevant to development policy due to their low tolerance for risk and inability to handle shocks. By understanding where disaster is most likely to strike and who is least equipped to handle those shocks, the government can prioritize its disaster relief resources.

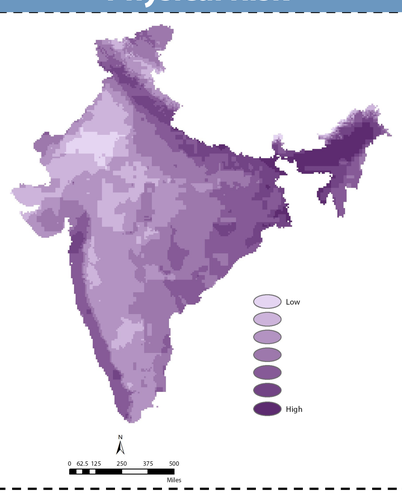
Combined Risk and Vulnerability Assessment



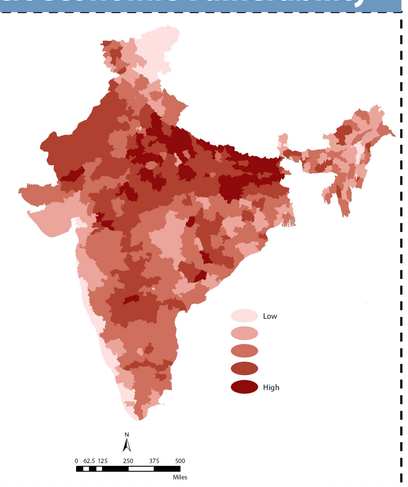
Land Use Risk



Physical Risk



Socioeconomic Vulnerability



Methods

Socioeconomic Vulnerability: Using vector data from the 2011 and 2000 Indian census at the district-level, a vulnerability score is used derived from the following factors: 1) population density, 2) percent of the district that is rural, 3) children under 6 years old, 4) members of a 'scheduled caste' (i.e. those who are historically disadvantaged according to an official designation), 5) percent who are agricultural workers, and 6) literacy rates. In particular, the score emphasizes the rural/urban divide because existing literature shows that rural farmers in particular are most vulnerable to monsoon disaster because it is more difficult to mobilize resources to less dense populations. Each category is ranked 1 to 4, where a higher score indicates greater vulnerability.

Physical Risk: There are two components that comprise the physical risk score, where a higher score indicates greater risk. The first component is based on historical average rainfall raster data through 2000 from WorldClim. There is physical risk due to rainfall, particularly during the monsoon season when there is either too much or too little (drought). Therefore, ranges were established derived from typical crop insurance rainfall payouts. These policies will pay farmers in the event of too much or too little rainfall. A score of 1 would indicate a range of rainfall that is typically healthy for crops grown in India. A score of 4 would indicate too much or too little for typical crops to thrive. The second component is based on historical flood data from 1985 to 2016, where each flood event it weighted by severity. Severity is based on a combination of deaths, injuries, and cost of damages. Because flood events overlap, a fishnet (grid) was overlaid on India and the severity value was joined to each 'cell.' Therefore, each cell had a value weighted by the number and severity of flood events. The flood data was then converted to a raster dataset to then the raster calculated was used to create an overall physical risk score where the flood and precipitation components are equally weighted.

Land Use Risk: Land use describes the classification of a particular area of land in 16 categories. This analysis used the Global Land Cover Facility raster dataset, where the data was reclassified on a scale of 1 to 4 based on risk. In this case, urban and built up was assigned most risky, followed by croplands, and then cropland/natural vegetation mosaic. All other land use categories received a score of 1 (least risky).

Limitations

Access to data was the main limitation of this analysis, especially since most meteorological spatial data from India is not publicly available, which is why this analysis largely relied on global data sets for rainfall, floods, and land use. The data is also not current, which would be ideal. More local data would have improved granularity of the analysis. Additionally, information regarding historical monsoon paths in India are not available and would have added precision to the analysis. The vulnerability analysis would have benefitted from more data, especially health data, although the existing variables should be sufficient and have high correlation with any missing data. Additional analysis could incorporate the cost of either not enough rain or damages from excessive rain due to monsoons.

References

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Data Sources

Socioeconomic Indicators (Vulnerability) and boundaries: India Census: 2011 and 2001 (compiled by ML Infomap)
Flood Data (Physical Risk): Global Archive of Flood Events, Dartmouth Flood Observatory, University of Colorado
Precipitation Data (Physical Risk): WorldClim 1.4 Bioclimatic variable 12 (BIO12)
Land Use: Global Land Cover Facility (GLCF), MODIS Land Cover
ESRI
Images: Wikimedia Commons

Projection: WGS 84 UTM Zone 44N

Results and Conclusion

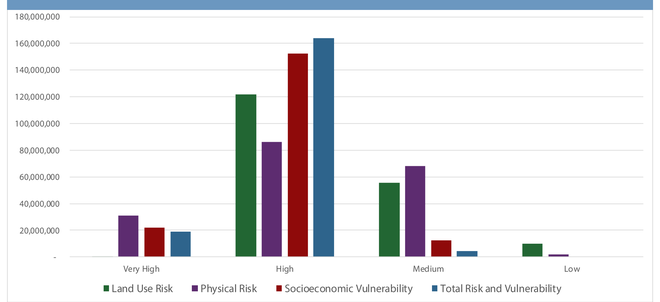
This analysis shows where populations are most vulnerable in the event of an extreme monsoon event. The table below highlights the top 20 most vulnerability districts based on the combined scores. The subsequent chart further provides information on the number of people in the agricultural sector most at risk broken down by type of risk.

Many parts of India are susceptible to the extremes of the monsoon season in India. The country is behind its peers in being able to mobilize resources when extreme events happen. The maps that accompany this analysis highlight the location of the most vulnerable populations based on important risk and vulnerability factors. The table below lists the top 20 most vulnerable districts to extreme monsoon events, while the chart illustrates that most of the agricultural workers in India are indeed susceptible to extreme monsoon weather. With hundreds of millions potentially harmed due to monsoons, the ability to see where those in need are is critical to effective risk mitigation.

Top 20 Districts with Highest Risk and Vulnerability Scores

District Name	Total Population	Total Agricultural Workers
Araria	2,811,569	746,137
Kishanganj	1,690,400	395,915
Supaul	2,229,076	592,518
Purnia	3,264,619	834,209
Siddharthnagar	2,559,297	508,418
Madhepura	2,001,762	569,184
Saharsa	1,900,661	410,659
Sheohar	656,246	-
Katihar	3,071,029	693,990
Madhubani	4,487,379	858,900
Uttar Dinajpur	3,007,134	386,335
Sitapur	4,483,992	893,569
Sitamarhi	3,423,574	-
Samastipur	4,261,566	772,109
Barabanki	3,260,699	666,874
Maldah	3,988,845	565,728
Khagaria	1,666,886	336,036
Sant Kabir Nagar	1,715,183	264,635
Mahrajganj	2,684,703	465,447
Saran	3,951,862	551,073

Number of Agricultural Workers by Type of Risk/Vulnerability to Extreme Monsoon Conditions



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