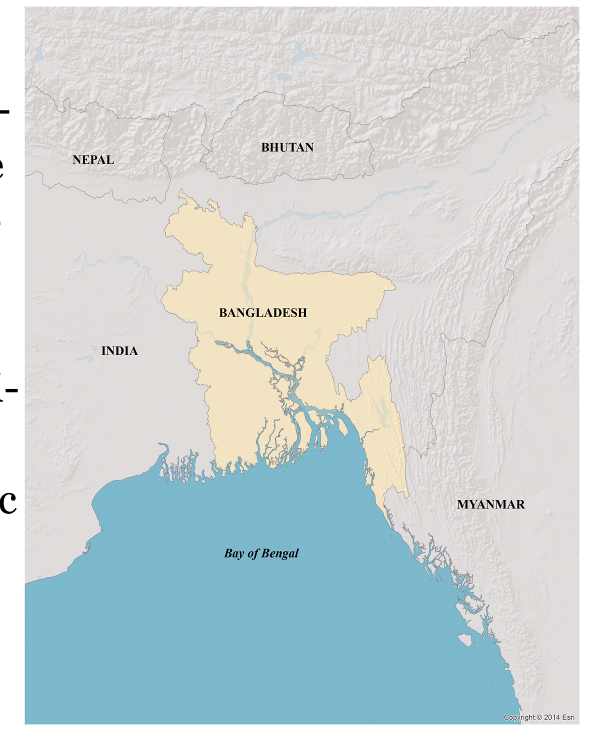
Swept Away? Mapping Flood-vulnerability in Bangladesh

THE FLETCHER SCHOOL
TUFTS UNIVERSITY

Introduction

On average, every year, floods engulf roughly 20.5% of Bangladesh, or about 3.03 million hectares (around 30,000 km). In extreme cases, such as the huge floods of 1988 and 1998 they inundated as much as 70% of Bangladesh. A combination of geographical location (as the drainage area for three huge river systems with their origins in China, India and Nepal), high rainfall, flat topography with very low elevation and extreme climate variability, make Bangladesh vulnerable to floods. In addition, high population density, poverty, and a predominantly agrarian economy, make Bangladeshi communities less resilient to climatic shocks.



This project tries to locate the most vulnerable districts (*zilas*) in Bangladesh, on the basis of data from 2011. It (a) calculates the *risk of external hazards* (such as flooding), (b) estimates *the ability of populations to resist climatic shocks* by examining their socio-economic characteristics, and (c) assesses the *resilience of populations*, to do so.

Methodology

The ordinary use of the word 'vulnerability' refers to the capacity to be wounded, i.e., the degree to which a system is likely to experience harm due to exposure to a hazard' (Füssel 2007, 156). An overall index of vulnerability was constructed on the basis of this definition, comprising 3 sub-indices. These sub-indices reflect environmental vulnerability, socio-economic vulnerability, and adaptive capacity. The most granular demographic information available on Bangladesh is district-level data sourced from the 2011 national census; this project therefore takes Bangladesh's 64 districts or *zilas* as their unit of analysis.

Environmental vulnerability has three components: average monthly precipitation from 1950-2000 (extrapolated to calculate average monthly precipitation upto 2013), proportion of agricultural land per district, and the proportion of low lying areas (10 metres or less above sea level) close to the three major rivers Ganges, Brahmaputra (Jamuna) and Meghna. These variables, meant to serve as proxies for flood risk and exposure to extreme weather, were assigned a score at the district level after being calculated (as described below).

Social vulnerability, meanwhile, consists of six anthropogenic factors that impact susceptibility to the effects of climate change, in each district: population density, the percentage of the population older than 70 and younger than 10, the percentage of the population employed in environmentally sensitive sectors such as agriculture, fishing, and forestry, proportion of households living in slums or slum-like housing, the proportion of households without access to safe drinking water and proportion of houses without sanitary toilets.

Resilience measures three indicators that serve as proxies for the ability to absorb the impact of flooding: the percentage of the population employed in fields other than agriculture, fishing and forestry, the percentage of the population that is either partially or fully literate, and the percentage of households with mobile phones (which I use as a proxy for household economic assets).

After compiling the variables above, every district was assigned a score from 1 to 5 for each indicator, based on the quintile in which it fell; 1 represented the least vulnerable, while 5 represented the most. For resilience, the evaluation is reversed; a high ranking on literacy, for instance, would earn a district a lower score. For each sub-index, the scores assigned to each district for relevant variables were summed, resulting in 3 sub-scores that were used to create the secondary maps below. Finally, the sub-scores were combined (according to the formula {Environmental vulnerability + Socio-economic vulnerability—Resilience}) to obtain a final measure of flood-vulnerability, which was used to generate the fourth map of overall vulnerability.

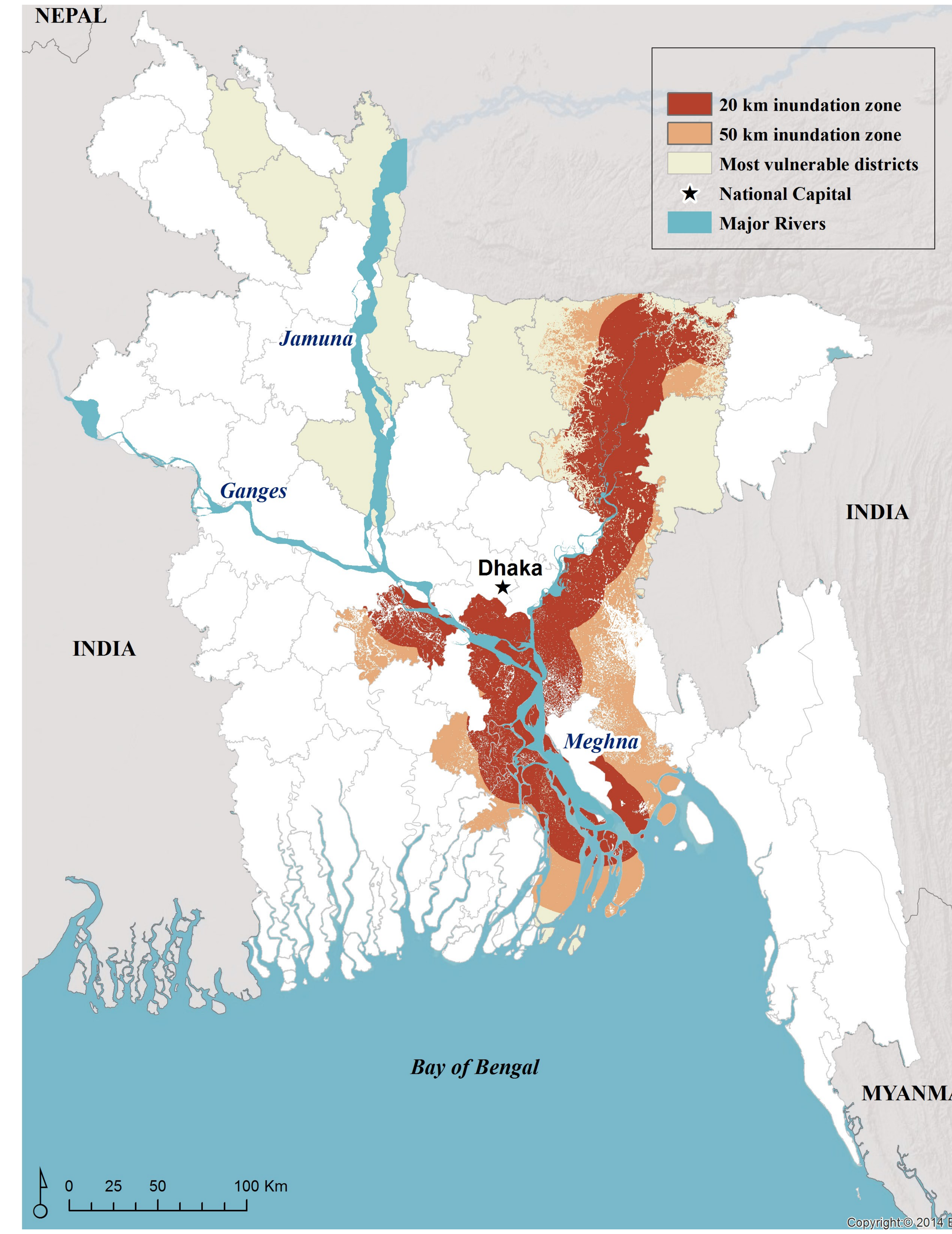
Limitations

Sub-district (*upazila*) socio-economic data could have helped refine the analysis in this project, however this was not available from the 2011 Bangladesh census. In addition, district-level household income data for 2011 was not available, and could have helped refine the analysis. Within districts, the livelihoods of certain groups is better adapted to coping with the effects of flooding, and this chart does not capture that data (although that data would possibly only be captured using widespread ethnographic research and data). Finally, this project does not attempt to capture the effects of rising sea-levels.

Conclusion

The most vulnerable districts were those in Northern and North-Eastern Bangladesh, largely (but not only) falling within the Brahmaputra-Jamuna river basin, and the Meghna river basin. The least vulnerable are the districts clustered in the southern part of the country. The map above highlights the most vulnerable districts in Bangladesh and identifies the low-lying areas (with elevation <10m) within 20km and 50 km of the major rivers, which are most vulnerable to inundation. I assessed 12 districts as most vulnerable: these are listed here, and are home to 31.1 million people, or 22% of Bangladesh's total population.

Potential risk of flooding



Most vulnerable districts

District	Population
Bhola	1.82m
Brahamanbaria	2.71m
Habiganj	1.96m
Jamalpur	2.3m
Kishoreganj	2.85m
Kurigram	2.05m
Mymensingh	5.1m
Netrakona	2.19m
Nilphamari	1.8m
Rangpur	2.84m
Sirajganj	3.1m
Sunamganj	2.37m

Sources

Cartographer: Aditya Sarkar

Date: 9 May 2016

Class: DHP207: GIS for International Applications

Sources of Data: Census 2011, Bangladesh Bureau of Statistics; ASTER Global Digital Elevation Map, NASA and the Ministry of Economy, Trade, and Industry of Japan; Global Land Cover Facility, University of Maryland and NASA; UN OCHA; WorldClim Global Climate Data; ESRI

Projection: Kalianpur_1975_India_Zone_IIb, Lambert Conformal Conic

Reference: Füssel, Hans-Martin. 2007. "Vulnerability: a generally applicable conceptual framework for climate change research." Global environmental change 17, no. 2: 155-167.

Mapping vulnerable districts