CHOLERA OUTBREAK IN IRAQ

A GIS analysis of environmental risk, security risk, and vulnerability that shaped the 2015 cholera outbreak

BACKGROUND

Cholera is an acute intestinal infection caused by ingestion of food or water contaminated with the bacterium ,Vibrio cholerae. It has a short incubation period, from one to five days, and produces an enterotoxin that causes a copious, painless, watery diarrhea that can lead to severe dehydration and death if treatment is not promptly given.

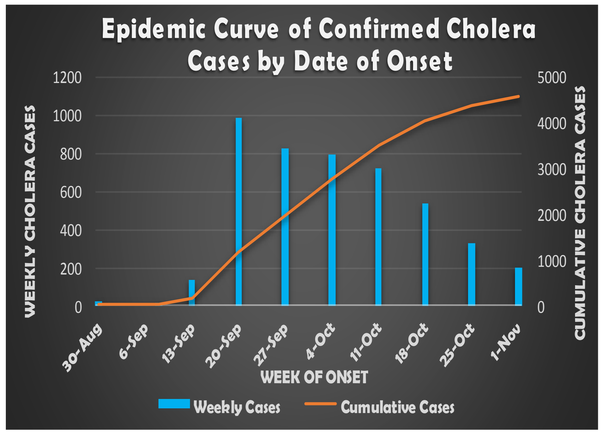
In 2015, there was an outbreak of cholera in Iraq. The WHO released three notices (dated 26 November 2015, 12 October2015, and 28 September 2015). The total number of affected persons with laboratory-confirmed cholera was 4,592 , with only 2 deaths. The outbreak was likely exacerbated by a few factors, including climate, shifting rain and drought patterns thus spreading waterborne cholera, and by conflict throughout the Middle East, which includes the existences of vast ungoverned regions, and a refugee crisis.

Limited resources could better be directed to prevent outbreaks if it were possible to assess the risk of an outbreak spatially. This project seeks to investigate health risk for cholera by identifying favorable biophysical, social, and economic preconditions for cholera outbreaks. The model is based on the assumption that endemic reservoirs of cholera occur and that environmental conditions exacerbate the spread of cholera. If the environmental preconditions are met, the subsequent spread of cholera depends mainly on socio-economic factors such as population density and access to safe water supply . This project focuses on the environmental preconditions, security factors, and socio-economic vulnerability factors that may predict the risk of cholera outbreak risk potential.

SPATIAL QUESTIONS

1. **What areas of Iraq have the highest risk for cholera outbreak?**
2. **Where did environmental factors, security risk, and socio-economic vulnerability shape the 2015 cholera outbreak in Iraq?**

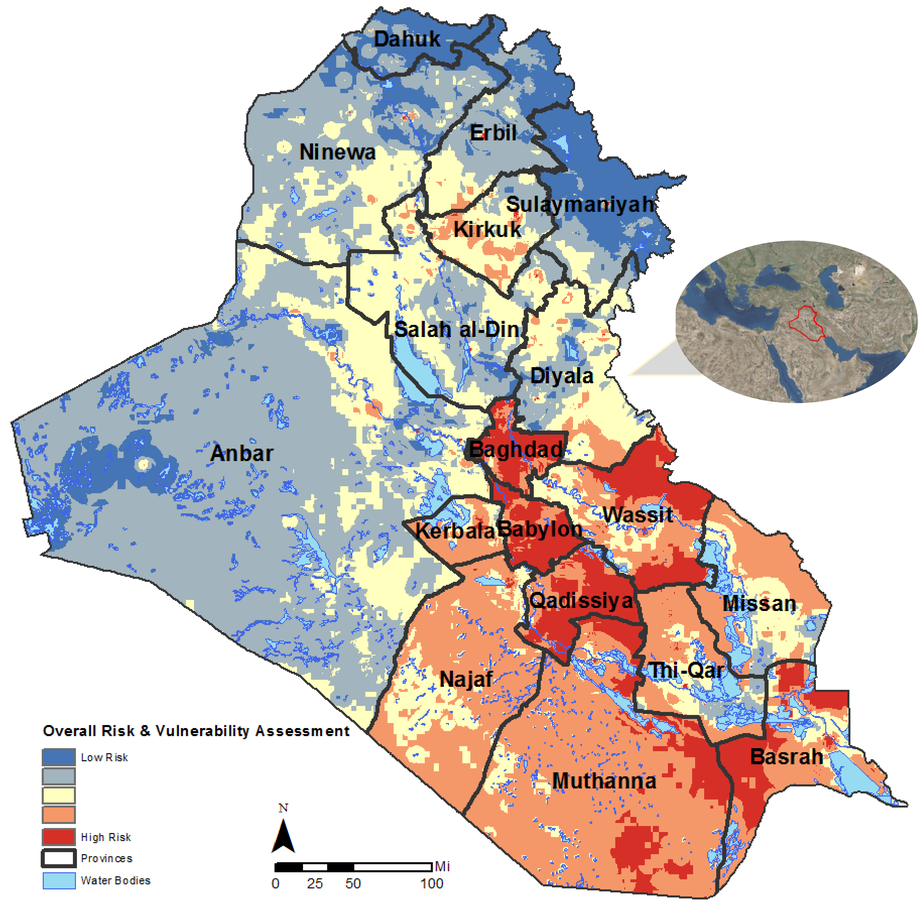
DISCUSSION



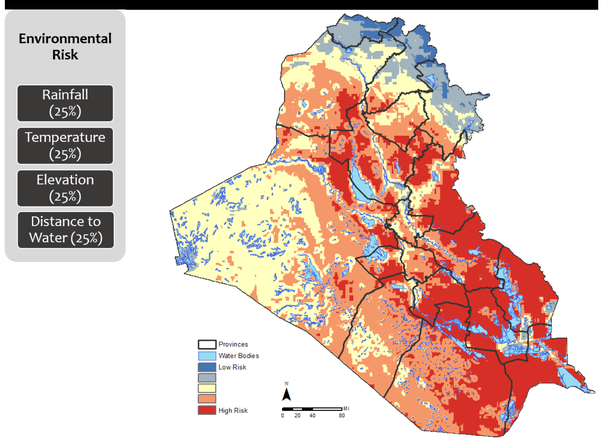
LEFT: The 2015 outbreak witnessed a cumulative total of 4,592 cases (orange line) throughout the year. The epidemic curve shows that 20Sep2015 and 27Sep2015 experienced the highest rate of new cholera cases (blue bar graphs).

RIGHT: The central and southeast portion of Iraq has the highest risk of cholera outbreak, based on the combination of environmental, security, and vulnerability factors. This darkest red, or highest risk, regions include some of the most populated regions of Iraq.

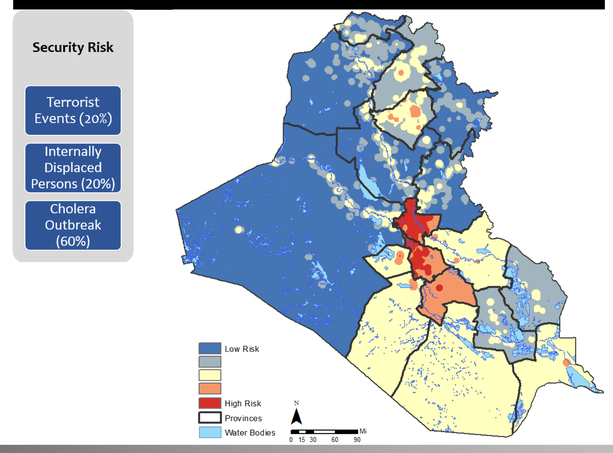
BELOW: Population at risk per province was calculated based on the number of individuals who were located in the highest risk category (dark red). The total population of Iraq that is at high risk of outbreak is 14,766,966. The total Iraqi population is 36.3 million, so the high-risk population for cholera outbreak represent 40.68% of the entire population. The provinces Qadissiya, Thi-Qar, and Baghdad, in the central and southeast region of Iraq, have the highest population at risk.



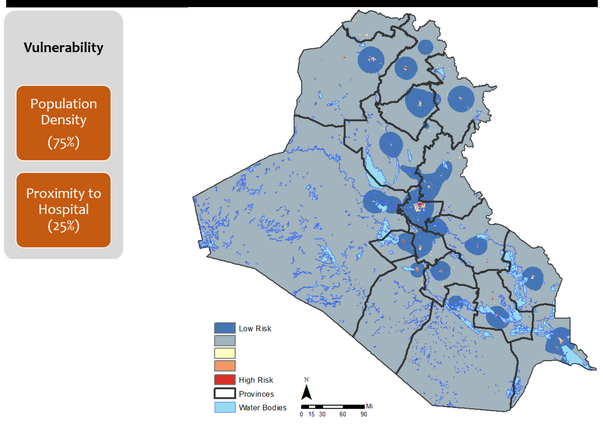
ENVIRONMENTAL RISK



SECURITY RISK



VULNERABILITY



POPULATION AT RISK

Province	Population At Risk
Qadissiya	722,820
Thi-Qar	626,875
Baghdad	619,245
Najaf	555,391
Wassit	490,921
Kerbala	407,349
Muthana	259,948
Missan	256,389
Basrah	136,726
Babylon	114,026

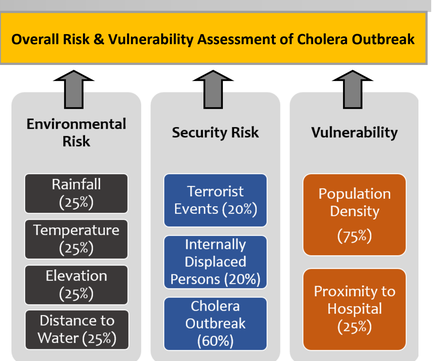
METHODOLOGY

Data Collection & Cleaning: Data was downloaded and imported into ArcMap. Previous cholera was not available as a shapefile; World Health Organization reports of province-level cholera data was imported as a rank to the administrative boundary level. Security, IDP, and hospitals were latitude / longitude points converted to XY coordinates. Hospital data had missing latitude and longitude data points that were manually entered. Raster data sets were resampled to 874.8x 874.8 cell size.

ArcGIS Analysis: Rainfall, surface temperature, elevation and population density were reclassified to reflect specific ranges of risk. Euclidean Distance to water bodies was calculated, then reclassified to reflect further distance to water as an increase risk. Kernel density of terrorist events, internally displaced persons, and proximity to hospitals was analyzed, then reclassified so that proximity to the events indicated certain risk of cholera outbreak.

Compilation: Environmental factors (rainfall, surface temperature, elevation, distance to water) were calculated and weighted equally, for a total risk classification of 1-5. Security risk (terrorist events, internally displaced persons, and previous cholera outbreaks) were calculated and weighted at 20%, 20%, and 60%, respectively, for a total risk classification of 1-5. Vulnerability (population density, distance to hospitals) were calculated and weighted 75% and 25%, respectively, for a total risk classification of 1-5 . All three categories, environmental, security and vulnerability, were calculated together and weighted equally at 33% each, for a total Overall Risk & Vulnerability classification of 1 - 15.

Population At Risk Calculation: The highest risk (dark red) areas were identified via reclassification and tied to the population density, using zonal statistics.



DATA SOURCES

1. **Rainfall:** National Aeronautics and Space Administration (NASA) GIOVANNI Merged Satellite-Gauge Precipitation Estimate, average for 2015 .
2. **Surface Temperature**: National Aeronautics and Space Administration (NASA) Land Process Distributed Active Archive Center (LP DACC) MODIS/Terra Land Surface Temperature and Emissivity Monthly L3 Global 0.05Deg CMG, monthly average for March through October 2015.
3. **Elevation:** Center for Global International Agriculture and Research (CGIAR) SRTM 90m Digital Elevation Data, 2008 data.
4. **Water Bodies:** United Nations Office for the Coordination of Humanitarian Affairs, downloaded from Humanitarian Data Exchange (HDX), 2004 data.
5. **Terrorist Attacks**: University of Maryland (UMD) Global Terrorism Database (GTB) Terrorist attacks, 2014 data.
6. **Internally Displaced Persons (IDP):** International Organization for Migration (IOM), downloaded from Humanitarian Data Exchange (HDX), 2014 data.
7. **Cholera Outbreak:** World Health Organization (WHO) Press Releases. The WHO press releases list the number of new cholera cases by province on September 28, 2015, October 12, 2015, and November 22, 2015. Cases were manually entered into province-level shapefiles.
8. **Population Density:** Geographic Information Science and Technology (GIST) Oak Ridge National Laboratory, LandScan ISOPop2005, 2010 data.
9. **Hospitals:** World Health Organization, Iraq Health Facility Matrix: Hospitals, 2004 data.

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Date: May 10, 2016
Course: DHP-P207-GIS for Int'l Applications
Projection: WGS 1984 UTM Zone 38N

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