Landmines in Cambodia: Prioritization of Demining

Background

Cambodia is one of the most heavily mined countries in the world, contaminated with both landmines and other unexploded ordinance (UXO). The weapons that remain a threat today were placed between the late 1960's and early 1990's. By the mid-1990's, over 181,040 square kilometers of Cambodia's territory was contaminated with an estimated 7 to 10 million landmines. Despite ongoing demining efforts, landmines continue to cause injury and death of individuals, poverty for communities unable to access their farmland, and stress for the health system, affecting civilians long after conflict has ended. In a country with limited resources and an enormous landmine contamination issue, priorities must be established to focus landmine clearance work.

Project Purpose

Which minefields in Battambang Province, Cambodia, should be prioritized for demining if the goal is injury/fatality prevention?

Demining can have a number of ultimate goals, including restoring contaminated agricultural lands, creating a safe space for roads or other infrastructure, promoting the return of displaced populations, and preventing injury. The goal will dictate how minefields are prioritized and chosen for demining. Taking the prevention of injury and/or death as the central issue, the purpose of this project is to look at various factors that may lead to injury risk in or near a mined area. Combining spatial data on these risk factors can be used as a method to identify minefields in areas of highest risk so that these minefields can be prioritized for clearance. The analysis focuses on Battambang Province in northwest Cambodia, one of the most heavily mined areas of the country.

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Map Projection: WGS 1984 UTM Zone 48N

Data Sources: National Institute of Statistics of Cambodia, Cambodia Mine Action and Victim Assistance Authority, Open Street Map, ESRI

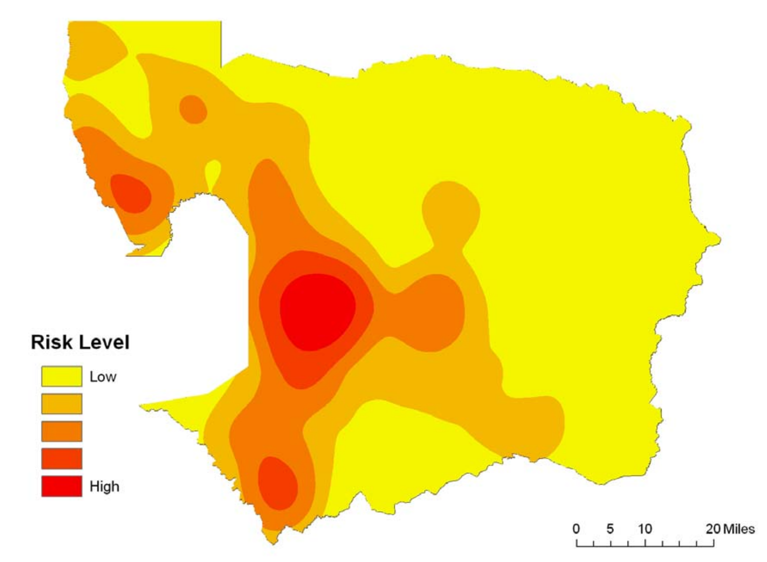
Data Validity: Mine Injuries (2006-2010), Population Data (Census 2008), Villages (2006), Health Centers (2006), Roads (2011), Schools (2007), Minefields (2010)

Methodology

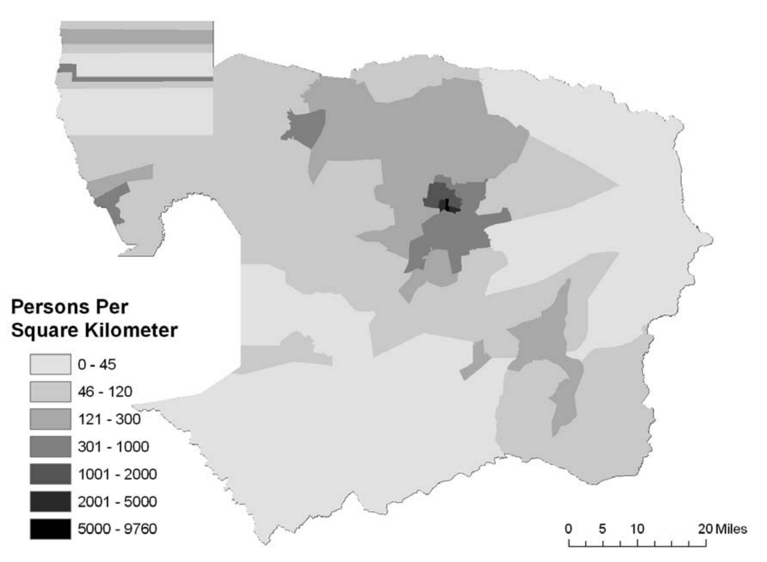
Through a review of studies done in Cambodia and other mine affected countries, seven factors were selected for use in the risk analysis. Minefields may have higher risk for causing accidental injury or death if they are in locations: near major roads, near a school, far from a health center, near a village center, near many prior injuries, with high population density, or with a high proportion of male residents.

Data on each risk factor was mapped, used to create a raster surface, and reclassified with values representing relative risk for injury or death. For each of the first four datasets, a distance surface was created. Areas closest to roads, schools, and village centers were reclassified to have a value of 10 (highest risk), while areas far from these points were assigned lower values based on distance. Areas nearest a health center were reclassified with a value of 1 (lowest risk, as injured individuals can more easily seek life saving medical care), with higher values assigned as the distance from the health center increased. A density surface was created from data on landmine and UXO injuries, as a location near several prior injuries would theoretically have more risk for additional incidents than one in which only one prior injury occurred – even if the distance to the injury location was the same in both cases. A distance surface would assign the same risk to each. Locations with the highest value in the density results were assigned a reclassified value of 10. Census data at the commune level was used to calculate population density (persons per square kilometer) and the proportion of male residents (as percentage of total population). Areas with higher densities of each were assigned higher values when reclassified in terms of risk.
Once all seven datasets were in a reclassified raster format, with values assigned from 1 to 10, they were combined to identify areas with highest risk (multiple risk factors). The Overlay tool in ArcMap Spatial Analyst was used for this purpose. The overlay resulted in a raster surface made up of grid cells – each with a number representing the combined risk based on all seven factors. Cells with all or most risk factors have the highest values.

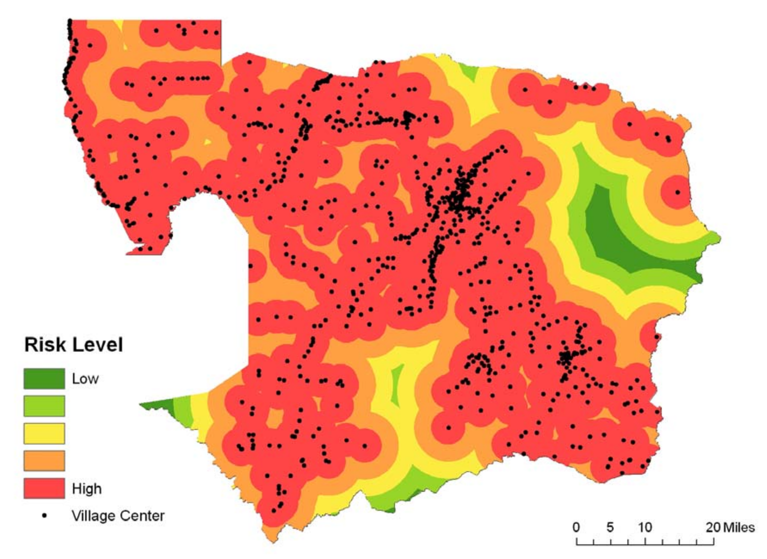
Density of Mine Injuries (2006 - 2010)



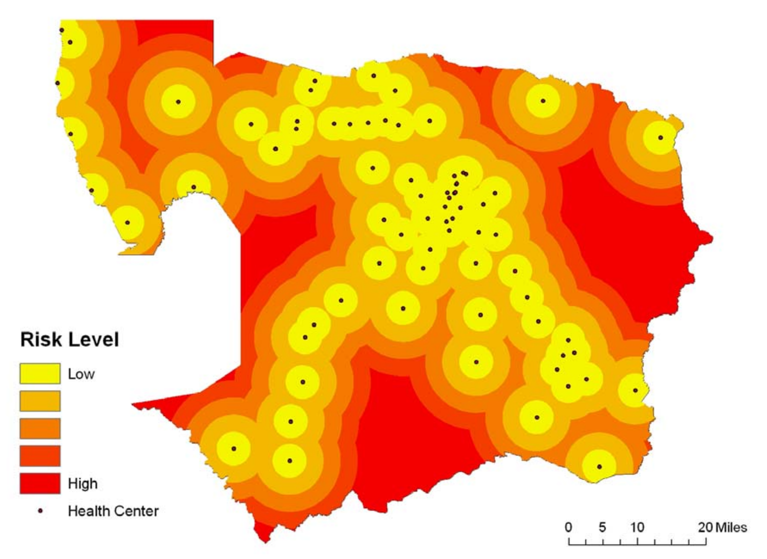
Population Density



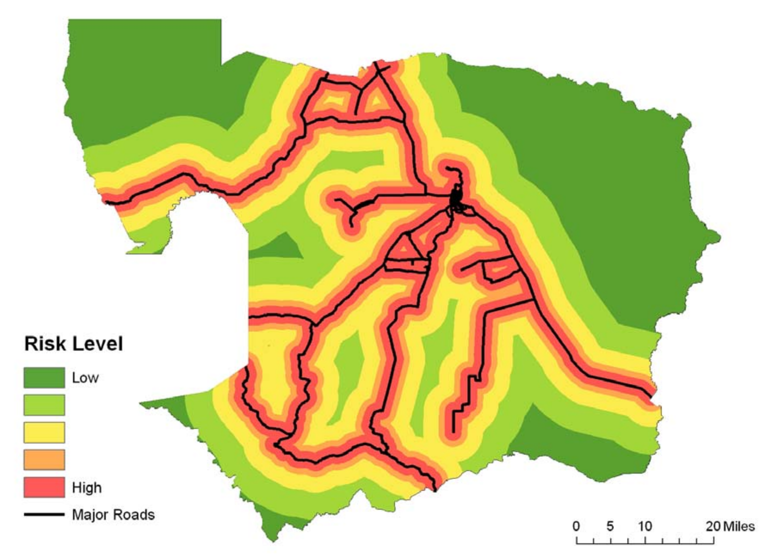
Distance from Village Centers



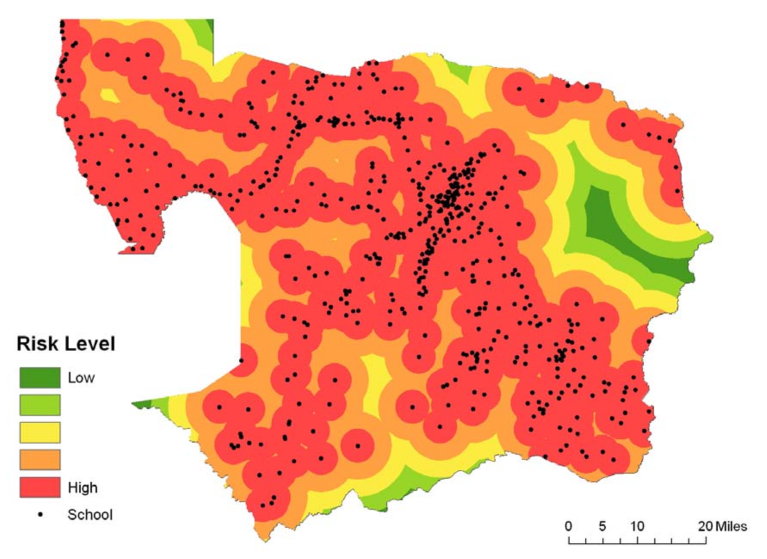
Distance from Health Centers



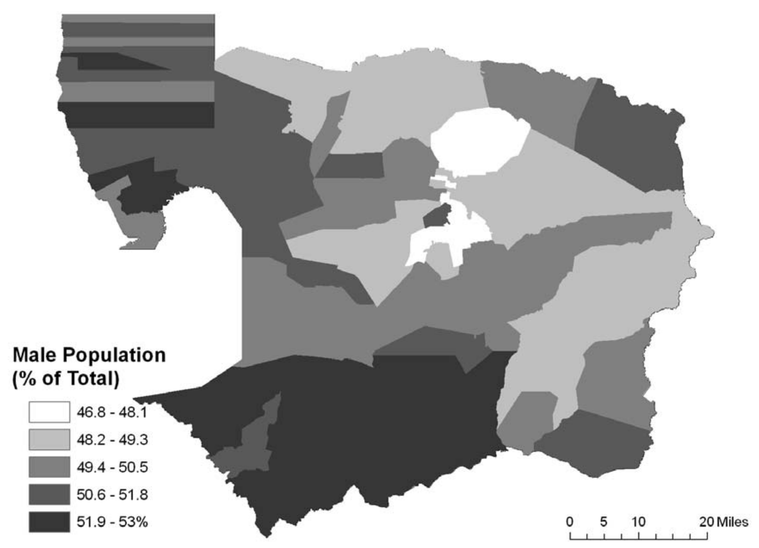
Distance from Major Roads



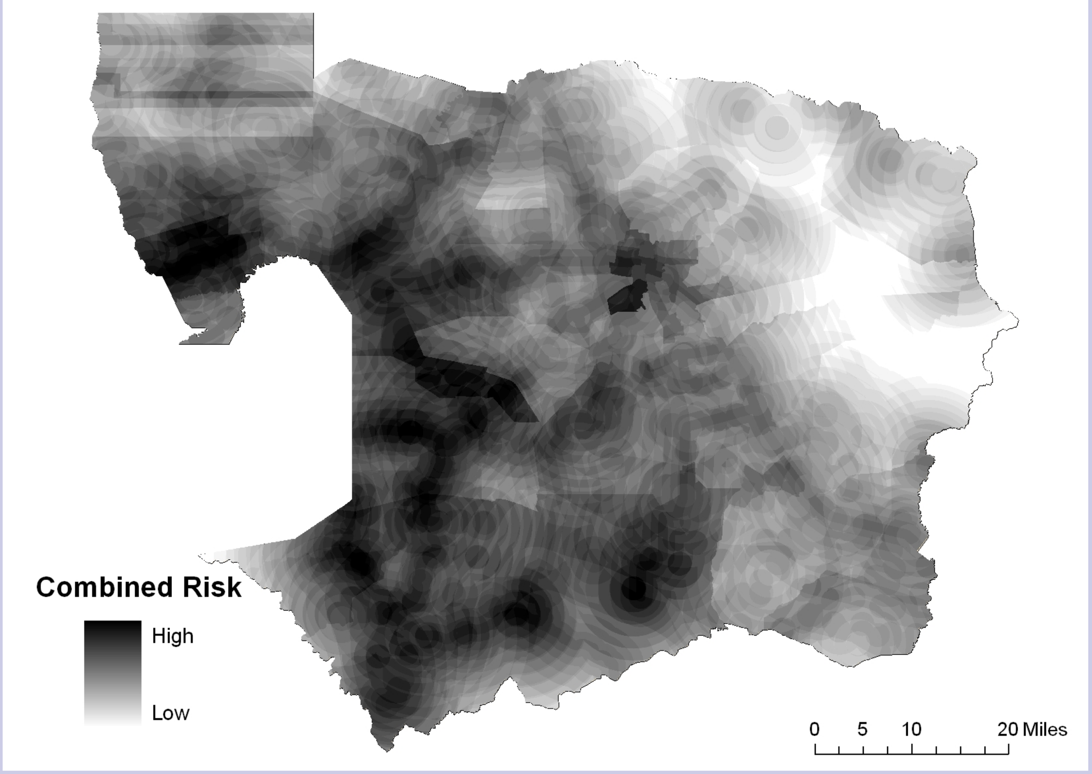
Distance from Schools



Male Population

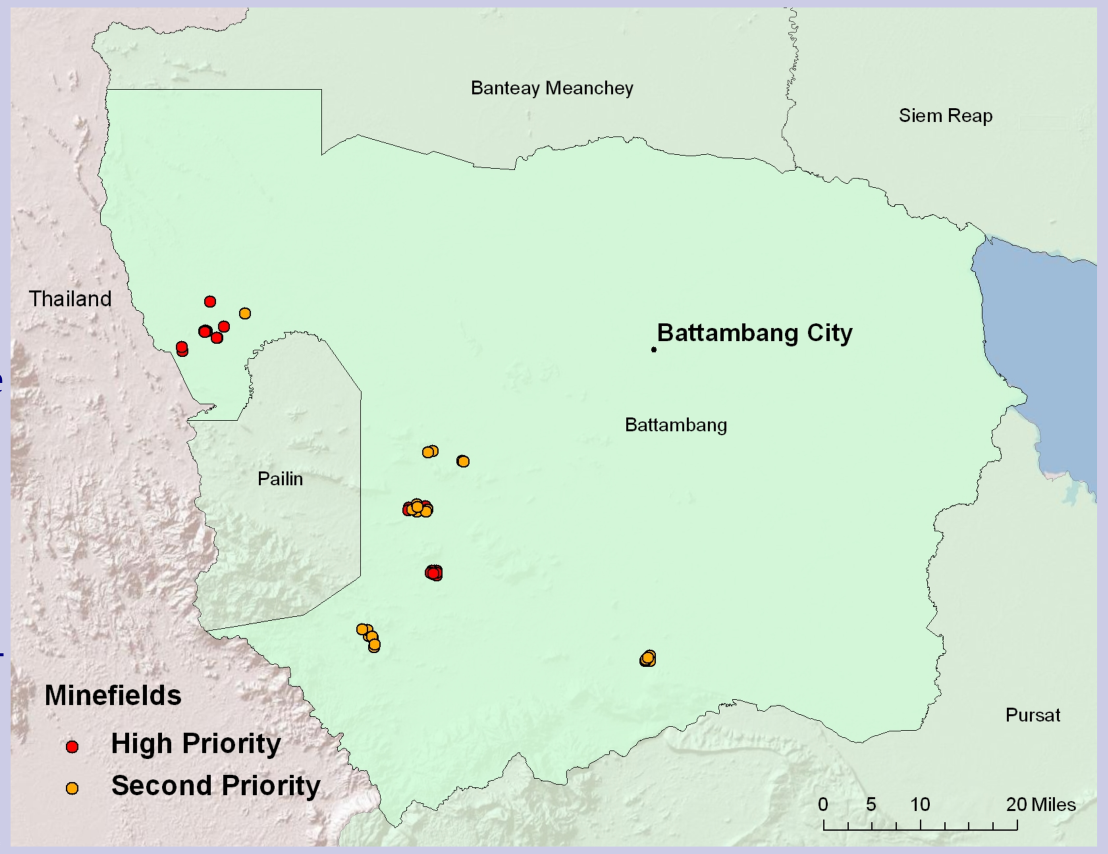


Result of Raster Overlay



Data on minefield locations was converted from polygons that outlined the fields into point data, with each point representing the center of the corresponding minefield. The value of the overlay raster cell in which each point was located was then extracted into the minefield point dataset. The minefield data was sorted based on that raster cell value. Minefields in locations with the top two raster cell values (23 minefields) were selected as the highest priority for demining. The minefields in locations with the following two highest values were selected as second priority. Depending on resources available for landmine clearance, a larger number of minefields could be selected as priorities based on this analysis.

Highest Priorities for Demining



Limitations

The main limitation to the analysis is the determination of the risk factors for the overlay. Studies done within Cambodia and in other mine affected areas were used to select factors and, while it is reasonable to expect similar risk factors would exist in each place, it may be possible that the Cambodian context contains unique elements that put people at risk for accidental landmine injuries.
One way in which this potential problem is mitigated is the use of data on past injuries in Battambang Province itself. If additional risk factors exist that were not used in this project, the pattern of past injuries would likely incorporate the influence of such a factor. Other limitations exist in the use of population data aggregated at the commune level, as the distribution within each area is masked by the analysis, and in excluding data from neighboring provinces, which may underestimate risk near the borders.