Landmines and Explosive Ordnance in Cambodia: Clearance and Risk

Background: A Legacy of Conflict
Cambodia is one of the most heavily landmine-contaminated countries in the world, with landmines being one of the primary weapons systems for all combatants in civil wars before, during, and after, the Khmer Rouge period. The area of most intense contamination lies along the Thai border, known as the K5 corridor, and was primarily cleared by the occupying Vietnamese military. Landmines downloaded from all over the world have been found in Cambodia, with the primary source countries being China, the United States, and Russia. Since 1979, more than 60,000 Cambodians have been killed or injured in landmine and explosive war "accidents." Cambodia was also heavily (and secondly) bombed by the United States, primarily in western Cambodia along the Vietnamese border, in order to eliminate cross-border safe havens for various North Vietnamese factions operating in Cambodia (Stevens, 1984). The distribution of approximately 120,000 US bombing strikes is shown in Figure 1, based on identified US Air Force targeting records, provided by the Cambodian Mine Action Center and the US National Aeronautics and Space Administration (NASA). Since the early 1990s, extensive international mine action efforts have attempted to rid Cambodia of landmine and explosive ordnance contamination, but extensive contamination remains (Figure 3, and even official humanitarian clearance operators do not always find all of the explosive hazards while clearing. Using information from CMAA, I identified hazard-free but hazardous clearance efforts have been made, with a specific focus on accident patterns by region and examined the safety of cleared land by comparing the clearance records to records of landmine and explosive ordnance incidents.

Methods:
To map the density of clearance tasks throughout Cambodia, I calculated the centroid of all clearance polygons by using the一脸 ngàn geometric feature, and re-projecting the 39 coordinates of the clearance polygons centroids. Using a density boundary layer as a mask, I created a raster layer displaying the kernel density of the clearance tasks, shown in Figure 3. To determine which landmine and EO incidents occurred on cleared territory, I used the "all operator" complete layer, and used a spatial join to connect the geocoded incidents to the cleared polygons layer. I also mapped the distribution of the remaining B5 polygons by using a spatial join to connect the B5 polygons to the commune boundaries layer. To show the geographic distribution of different categories of incidents (based on device type), I selected all incidents caused by mines and all incidents listed as having been caused by EOD (EO was not present in the geocoded data), and used spatial joins to connect these sub-lists to the commune boundaries layer. A spatial join to connect the entire geocoded incidents to the commune boundaries, as there are no key differences between the distribution of landmine and EO incidents geographically which were not apparent in the aggregate information that is generally presented.

Results:
Figure 3 displays the key piece of analysis which shows that the incidents on officially cleared land do occur in the densest areas of clearance, as well as clusters near the Thai border. The incidents on cleared territory took place in 15 provinces, with the highest rate of accidents on cleared territory per square kilometer of cleared land, at about the twice-average rate (Figure 5). Figure 6 shows that the share of accidents on cleared territory is higher than the share of accidents reported, as the data were not available for all provinces. The findings regarding incidents on cleared land are evidence to support conclusions made in Miliband at al.'s article which states that community trust in the safety of the product of demining work is critical to ensure that cleared land is put into productive use immediately, which is necessary to recoup (in the aggregate) the resources expended on the demining process itself.

Conclusions:
The determination that at least 170 incidents have been recorded on officially cleared territory is problematic, because to my knowledge, none of these incidents have been investigated according to the protocols contained within International Mine Action Standards 10.60 Reporting and Investigation of Demining Incidents,” although this standard is written more for those incidents which occur during the demining process itself. The findings regarding incidents on cleared land are evidence to support conclusions made in Miliband et al.'s article which states that community trust in the safety of the product of demining work is critical to ensure that cleared land is put into productive use immediately, which is necessary to recoup (in the aggregate) the resources expended on the demining process itself. (Milley, 2002, 2006). Figure 9 shows the distribution of all incidents in Cambodia, while Figure 7 shows the distribution of landmine incidents. The mapping of landmine and EO incidents, which was supposed to be contextual, was surprising because it showed a high concentration of TOE incidents in central and western Cambodia (Figure 6), which is surprising because the bombings which would have produced the majority of the TOE contamination (in the form of unplanted cluster submunitions) are concentrated in Eastern Cambodia. This supports econometric analysis that suggests there is a significant movement of ordnance from eastern to western Cambodia in order to exploit the higher prices in Thai scrap compared to their Vietnamese counterparts, which is further supported by the large number of EO incidents which appear along the main road west to Siem Reap from eastern Cambodia (Roberts, 2011).

References: