The Road Less Traveled

Risk Analysis of Migration in the Sonoran Desert of Arizona

Introduction

It is no secret that the Sonoran desert is one of the deadliest migration routes in the world. Indeed – since 2000, over 3,199 human remains of unauthorized migrants have been recovered from the Sonoran desert of southern Arizona. For this reason the purpose of this project is to explore the following: first and foremost, where do these migrants perish? Secondly, what vulnerability factors are present where they perish? Investigation into variables such as: heat, proximity to roads, presence of law enforcement, proximity to water sources, proximity to roads, proximity to where other migrants perished, can be combined in a raster calculation in order to determine what areas of the Sonoran desert can be said to contain higher danger of travel and indeed increased vulnerability. The result of this project is to determine where in the Sonoran desert, as determined by these variable is the most dangerous. It is worth noting that as most of these migrants are traversing the desert by foot, this "danger of travel" refers to how difficult certain areas of the Sonoran desert will be to traverse by foot.

Methods

Firstly with regard to the roads and streams / waterways present in the Sonoran desert, a Euclidean distance tool was utilized. After determining what distances are significant for distance from an item, the classify raster tool was used on both variables. The class differentiations for each respective raster indicates each mile a migrant becomes farther away from a roadway or access to water, the more perilous or dangerous their journey becomes.

Secondly, an analysis of the average temperature throughout the year was used to determine which areas of the Sonoran desert are the hottest. Using a similar classify raster technique 5 distinct zones of heat were included, with the hottest areas being 113 Fahrenheit + and the lowest temperature areas being below 80 degrees. Higher temperature means higher danger of travel.

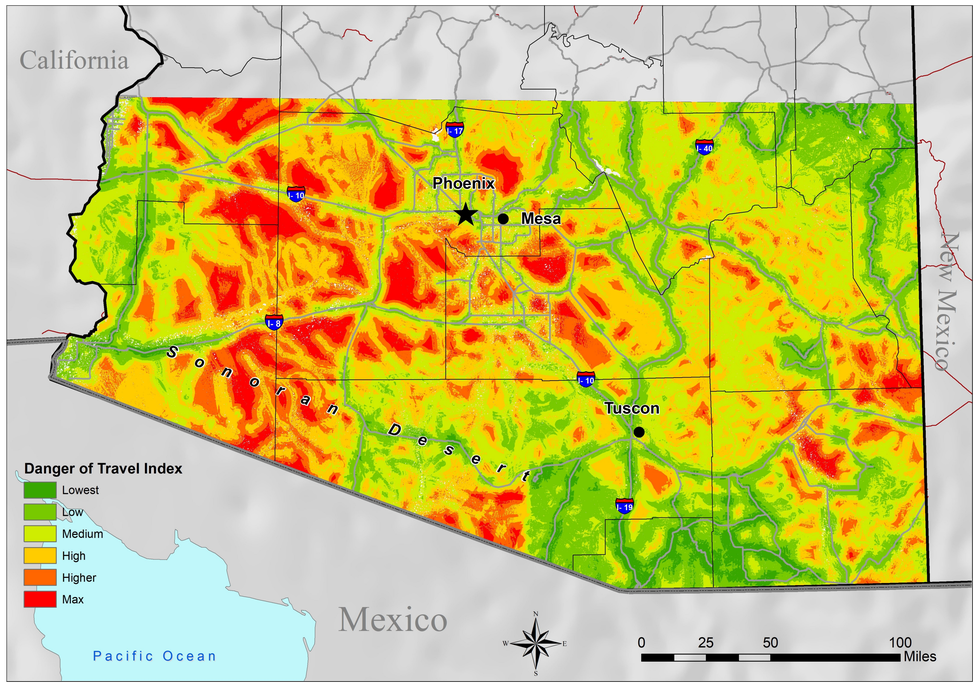
Next a data set of migrant remains discovered was used to determine which areas have migrants already perished in. These points were converted to a raster set through a kernel density smoothing operation, and based on the density of migrant events per area a score was given. Areas with a high incidence of migrant deaths were given a higher score.

Subsequently an index of "ruggedness" was determined. Ruggedness is how quickly the slope changes at any given point. It is a commonly used index to score the difficulty by foot of a various range. A high score of ruggedness was given a high score due to the fact that terrain that is rapidly changing in a given area can be safely assumed to be more challenging and taxing to traverse.

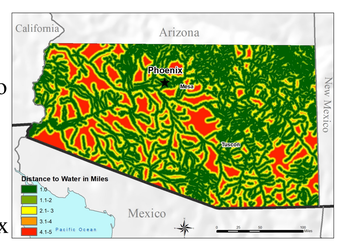
Lastly, a dataset that included border checkpoints was used to determine where aid may be located. Using a similar Euclidean distance to raster reclassify tool 5 classes were determined each broken down into miles from aid. I was assumed that the farther away from a border checkpoint the more perilous a journey was.

Once all variables had been reclassified per the aforementioned process, the raster calculator can be used to determine a danger by travel on foot index of the Sonoran desert. Areas with a higher danger (i.e difficulty or danger of travel) were given orange / red coloration, and areas with a lower danger were given a green / yellow score.

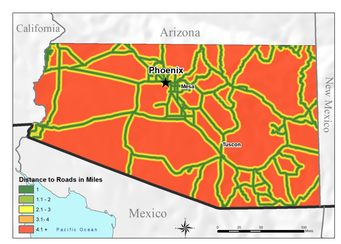
Danger of Travel Index



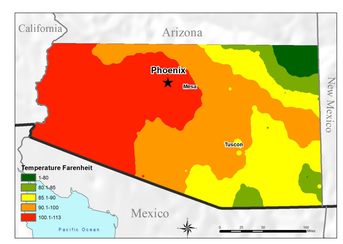
Distance to Water in Miles



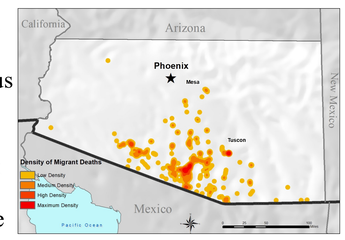
Distance to Roads in Miles



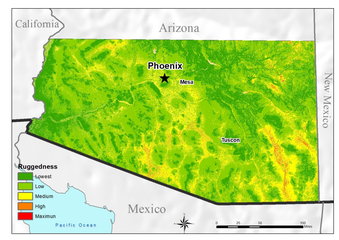
Temperature in Fahrenheit



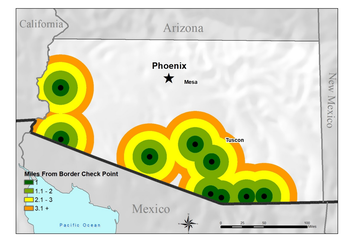
Density of Migrant Deaths per kilometer



Ruggedness of Terrain per area

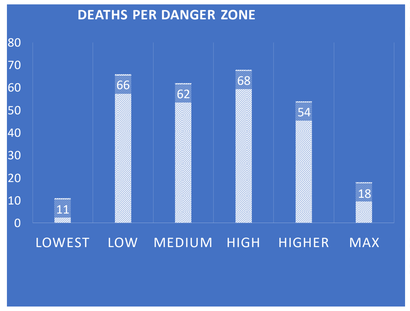


Distance to Border Checkpoint in Miles



Findings

Once all of the various factors were classified, added, and combined, the subsequent map to the left was determined. As was expected, the most dangerous parts of the desert for travel by foot are the areas that are the hottest with the least access to roads, waterways, and border checkpoints. However, surprisingly, the area that is the most dangerous to travel (red) seems to be concentrated in the western area of the Sonoran desert. This is surprising as when compared to the migrant deaths per meter density map, there is relatively little impact on the final product. With this information it was then possible to use the points of where the migrant remains had been found, and calculate what zone (lowest, low, medium, high, higher, max) was found to be the "deadliest". Using extract value by point and juxtaposing the "score" of each migrant death point, the subsequent chart was able to be determined. As can be seen in the chart to the left, it would seem that there was an almost even split between the medium three categories, with the most recorded migrant fatalities occurring in the "High" category. Significantly, however, of the 279 reported remains of migrants that have been discovered, there was an even split between the top three categories, 140 bodies respectively (High, Higher, Max), with 139 bodies being discovered in the other (Medium, Low, Lowest) categories. If using this data to inform decisions is assumed, then perhaps no clear conclusions were reached with regard to migrant vulnerability and this analysis. However, there are some limitations that warrant consideration.



Limitations

While the finding of the dangerous areas for migrants by foot is important, it is necessary to take into account the fact that many migrants bodies may in fact never be recovered. This could be of paramount importance to this analysis, as it could change the distribution of migrant deaths per zone to favor the more dangerous areas as individuals may not be as prone towards discovering remains in remote areas (High, Higher, Highest). Therefore, while this analysis found an even split between moderate and less moderate zones, this by no means proves that the higher score areas are as dangerous as the less dangerous areas.

Additional Information

Cartographer: Benjamin A. Noelle

Class: DHP P207: GIS For International Applications

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GIS Data Sources: Chamblee, John & Christopherson, Gary. (2006). Mapping Migrant Deaths in Southern Arizona: The Humane Borders GIS. Bodily Inertia and the Weaponization of the Sonoran Desert in US Boundary Enforcement: A GIS Modeling of Migration Routes through Arizona's Altar Valley.

Image Citations: Man Walking in Desert, Caia Science Photo Library, Desert Skull, Brandt Water Strategies, April 2, 2004

Projection : NAD_1983_StatePlane_Arizona_Central_FIPS_0202

THE FLETCHER SCHOOL

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