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Understanding the vulnerability of the population of Afghanistan under multiple natural and anthropogenic risks with an indicator-based analysis

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Understanding the vulnerability of the population of Afghanistan under multiple natural and anthropogenic risks with an indicator-based analysis

A Thesis Presented for the
Master of Science
Degree
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Matthew Repine Miller
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DEDICATION

I would like to dedicate this paper to the Soldiers and Afghan Interpreters with which I have served in Afghanistan. Without your support and protection this project would not have occurred.

ACKNOWLEDGEMENTS

I would like to thank my family for supporting me through long years of academic pursuits and while serving around the world with the United States Army. Without their support I would not have achieved any measure of success.

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ABSTRACT

The purpose of this study is to understand the vulnerability to natural and anthropogenic hazards of the population of Afghanistan and the social factors which enhance or moderate such vulnerability. While vulnerability studies are commonly conducted in the United States, as well as many other global north countries, most studies of this type utilize data collected by central government entities in the form of a census which is periodically executed and uses standardized collection methods. In the case of Afghanistan, and many other countries in the global south, such data is hard to acquire, lacks a high level of confidence, or does not exist. For these reasons, this study will focus on efficiently utilizing data which has been collected by the Central Statistics Organization of Afghanistan, as well as data compiled and made available by the Oak Ridge National Laboratory (ORNL) Geographic Information Systems and Technology (GIS&T) Group to identify the most significant indicators of vulnerability within the population of Afghanistan. The result of this study is a by district analysis of the country of Afghanistan, in which vulnerability to hazards is inferred for the population of each district and ranked based on the relative vulnerability of the population. This information can assist the Government of the Islamic Republic of Afghanistan, as well as other aid organizations, to prepare to respond to humanitarian crises more effectively.

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INTRODUCTION

Despite the reduction of Coalition Forces members in the Islamic Republic of Afghanistan and positive political developments within the last 5 years, significant instability continues to exist throughout the country, presenting hazards to local populations and resulting in continued displacement of Afghan civilians as either Internally Displaced People (IDP) or Refugees. “2015 witnessed the highest number of civilian casualties since 2009 and saw a dramatic increase in conflict-induced displacement” (2015 UNHRC Year End Report) The total number of IDPs in Afghanistan in 2015 was 1.2 million. Studies of vulnerable people originating from Afghanistan have tended to focus on the conditions present at their destination following displacement. And while the above statistics show the scope of the problem of displacement, all displacement in the U.N. study is attributed to the ongoing conflict in Afghanistan between the current government with support from the NATO Coalition, the former ruling Taliban party, and various other militant groups and power brokers operating in Afghanistan. However, conflict should not be the only consideration, as other hazards often create the desire or necessity to relocate in a group of people. Anthropogenic and natural hazards exist that are often difficult to predict, and evolve over time, which create less than ideal conditions for human habitation. With this study, the intent is to look toward the indicators that identify increased vulnerability and the quantification of those factors to help observers identify when conditions are present that are likely to create these humanitarian crises.

Studies of Afghan Refugees residing in Iran and Pakistan have developed a clearer understanding of the conditions refugees face in their relocation point (Lohdi 1998, Sturridge 2011), however fewer studies are available to understand the conditions faced by the 1.2 million IDP’s within Afghanistan nor of the estimated five million Afghans who have been repatriated since the U.S. invasion in 2001. Additionally, with an estimated overall population of 30.5 million people, continued political instability and the presence of multiple natural hazards, a set of conditions for continued humanitarian crises for which the current government does not have resources available to efficiently respond continues to exist. Analyzing human vulnerability can help to understand the underlying conditions of vulnerability, and support government and non-governmental entities efforts to prepare for and respond to potential humanitarian events. This type of study can also help to identify places which are underserved by government and non-government entities, and support decision makers in pursuit of increasing support in these areas.

Thesis Statement

- How vulnerable is the population across Afghanistan with respect to multiple natural and anthropogenic hazards/risks?

- How are districts across Afghanistan more or less vulnerable compared with others with respect to multiple hazards/risks?

- Given a large set socio-demographic indicators, is there a way to assist a stakeholder in analyzing vulnerability while taking into account her/his unique perspective/value?

- Given the results of this analysis, is there a way to assist policy makers in identifying plausible actions to reduce vulnerability in the populations at greatest risk?

Justification

The study of human vulnerability is an ever evolving discipline, with wide ranging applications by governmental and non-government organizations to assist in planning and responding to humanitarian crises. This study aims to help refine this discipline utilizing a mixed methods approach which answers some previously identified shortfalls in this type of study. Utilizing the Analytic Hierarchy Process into vulnerability studies will streamline a human vulnerability study in three ways:

- AHP assists in structuring the problem of a vulnerability study in an efficient way and supports a shared understanding of the study across a range of stakeholders
- AHP captures the preferences of an unlimited number of stakeholders and converts to ratio scale for comparison
- Calculations made at various levels of AHP can be isolated and analyzed to better understand how those preferences enhance the shared understanding of vulnerability analyses results

Literature Review

Within vulnerability studies, a number of methods have been developed to try and understand the ways in which exposure to hazards will affect people in various ways, even in geographically nearby places. “The degree to which populations are vulnerable to hazards is not solely dependent on proximity to the potential source of the threat.” (Cutter 2000). Within this type of study, numerous conceptual models have been proposed to help analyze vulnerability, which will be compared below.(Cutter 2003, McLaughlin 2008, Blaikie et al. 2014)

Risk/Hazard Model: The Risk-Hazard (RH) Model was an early type of risk assessment model which focused on understanding the impact of a hazard as a function of exposure to the hazardous event and the sensitivity of the entity exposed. (Turner et al. 2003) This model has been widely used in environmental and climate impact assessments, beginning with a focus on the hazard and quantifying the impacts of those hazards. However, this model has been identified as insufficient for detailed vulnerability analysis as there is no method to account for the variable vulnerability of the receptor (population). Turner et al. identified three shortcomings of this model in their 2003 article "A Framework for Vulnerability Analysis in Sustainability Science". They are:

· The way in which the system in question will amplify or attenuate the impacts of hazard
· Distinctions among exposed subsystems and components that lead to significant variations in the consequences of the hazards.
· The role of political economy, especially social structures and institutions, in shaping differential exposure and consequences.

For these reasons, the RH Model is an ineffective method to conduct a detailed vulnerability assessment, given its inability to modify the risk based on variations in adaptation of individual nodes within the system at risk. Through these critiques, the pressure-and-release (PAR) model was developed.

PAR Model: The PAR Model incorporates similar variables to the RH model, however it pays special attention to the variation of vulnerability by different units within a system, which is absolutely imperative when discussing human vulnerability. The PAR model has a greater focus on how various groups within a society can be effected by, and respond to, the presence of a hazard, and how that varies between groups (Blaikie et al. 2014). This is particularly important when discussing vulnerability analyses within regions such as Afghanistan, where many groups live in ancestral homes with a strong social support system and historical adaptation mechanisms, but that also include large populations of recently displaced people whom it can be assumed lack many of the same adaptation techniques and resources.

The PAR model focus on the 'pressure' or application of factors which create hazards to the receptors which include natural and man-made hazards such as extreme weather and conflict, but also in the conditions that various groups experience due to individual circumstance, such as access to resources and proximity to and reception of government assistance. These 'pressures' are depicted by the PAR model (Blaikie et al. 2014) as being applied from two sides to the receptors at the 'disaster' phase. Hazards are applied at one end, and the 'progression of vulnerability' at the other. Some researchers use the analogy of a vice or 'nutcracker' to describe this system of pressure being applied from two sides, with that pressure indicating the vulnerability produced.

It is important to note that there are three sets of root causes within the 'progression of vulnerability' and that these root causes become more and more specific when approaching the 'disaster' phase in the model. It is important to include this focus, and to incorporate in these analyses as they refine the model. To 'release' this pressure, the model incorporates the adaptation techniques which lower the magnitude of the reception of risks. However, what is most important is in referring back to the three stages in the 'progression of vulnerability'. For there to truly be a release of the pressure caused by the progression, changes must be addressed throughout each of the three stages. The entire chain of causation must have the pressure released, or else there will not be a measureable and sustainable effect on the overall pressure which will cause the ‘disaster’.

In “At Risk” Piers Blaikie, Terry Cannon, Ian Davis and Ben Wisner identify two shortcomings in the PAR model. The first is that this model does not provide an analysis of interactions between the environment and society at the ‘pressure point’ (Blaikie et al. 2014), or the point where the disaster begins to present itself. Additionally, the PAR framework is considered generally static, and unable to show the evolution of aspects of vulnerability it is trying to identify. This is especially relevant during and immediately following a disaster, as changes in most aspects of social life will occur rapidly and often in great magnitude.

Access Model: Due to the reasons identified previously, the authors of “At Risk” developed the ‘Access Model’ which does not focus so significantly on the disaster, but rather at the small scale variations in adaptation, and particularly in identifying how those adaptations techniques evolve. The Access Model “sets out to explain at a micro-level the establishment and trajectory of vulnerability and its variation between individuals and households.” (Blaikie et al. 2014). While this system could be very effectively implemented within a community level vulnerability assessment, it would be difficult to look so precisely at vulnerability in a large scale such as the state or national level and especially so in locations where information is difficult to access.

In addition to the conceptual models which have been utilized in vulnerability studies, a conceptual model that is leveraged to explore the question of vulnerability has been utilized as well.

Social Vulnerability Index: The Social Vulnerability Index (SoVI) utilized in articles such as “Temporal and spatial changes in social vulnerability to natural hazards” (Cutter 2008) is an additive model utilizing metrics which are collected and recorded at the national level, such as the U.S. Census, to gather metrics at more precise scales that can be analyzed and describe socially vulnerable areas. This method is very useful when such data is collected at regular intervals and is made available to the public, especially given standardized collection methods and indexes so that relative vulnerability between study areas can be identified. The SoVI is a method to understand the ‘release’ portion of the PAR model, as it identifies which people or communities are ablest to respond and adapt to the presence of a hazard.

Utilizing the SoVI in less developed countries will present challenges, as national level census may be conducted rarely if ever. In order to gather such data, alternative means will need to be implemented which most closely estimate similar conditions and allow researchers analyze them.

There is also a separation in studying how effects of hazards can be analyzed, either as vulnerability or resilience (Cutter 2008). Selecting how and when to use these similar yet particular aspects is very important. Vulnerability is considered the pre-event conditions present in a location prior to a hazardous event that can indicate the potential for harm to a population group. Resilience takes into account the ability of a social system to respond to and recover from disasters. Most importantly, it includes the adaptive processes that facilitate the ability of a social system to reorganize change and learn in response to a threat (Cutter 2008). The decision to use one or the other option is often based on availability of data, as resilience requires a deeper understanding of the cultural circumstances of the study area.

Before we continue, we must ensure we have defined the following characteristics of this study effectively. First we must understand the difference between hazard, risk, and vulnerability. Hazard addresses the potential for conditions to exist that might injure, kill or otherwise negatively affect human life. However, risk does not exist without the presence of a receptor to which that hazard is exposed. Thus, if there are no people affected by the hazardous condition, there is no risk. However, because the living conditions of all humans vary significantly, the same magnitude of exposure to a hazard will not create the same risk for all people. Individual adaptation and mitigation techniques exist, and thus can reduce the risks faced by humans. Once these adaptation and/or mitigation techniques have been accounted for, we can more clearly assess the remaining risk, which is categorized as vulnerability.

CHAPTER I

ASSESSING THE VULNERABILITY OF THE AFGHAN PEOPLE UNDER MULTIPLE PHYSICAL AND ANTHROPOGENIC HAZARDS

Abstract

The purpose of this study is to assess the vulnerability to multiple physical and anthropogenic hazards of the Afghan population. This study leverages the multi-criteria decision analysis model Analytic Hierarchy Process (AHP) and the Pressure and Release (PAR) model of vulnerability taking into account exposure to probable hazards, as well as the adaptation and/or mitigation capabilities to assess vulnerability to individual hazards as well as the cumulative vulnerability when all hazards were considered collectively. With the use of AHP, we developed a ranking of vulnerability indices for each of the 329 districts in Afghanistan with respect to individual hazards and cumulative vulnerability. Physical risks included in the analysis were earthquake, landslide, flood, drought and wildfire. Anthropogenic risks included exposure to armed conflict and food insecurity. The rankings of vulnerability were used to explore spatial patterns of vulnerability across the Afghan landscape (e.g. hot spots of vulnerability). Results show that areas with high vulnerability to anthropogenic hazards are associated with districts remotely located from Kabul, the nation's capital and seat of government. With respect to physical hazards, two distinct patterns were observed. The first of which showed clusters of areas vulnerable to geologic hazards in the highlands of Afghanistan. In contrast, high relative vulnerability to climatic hazards were observed in the low lying, desert and arid regions of the country. Our analysis show that high capacity of adaptation and/or mitigation (e.g., health facility, transport network) can significantly reduce the overall vulnerability in areas even with high hazard exposure. however, areas of moderate hazard exposure but without adaptation and/or mitigation capabilities might make the population more vulnerable. These findings can support future policy decisions in prioritizing support to the most vulnerable districts throughout Afghanistan.

Introduction

Throughout its history, Afghanistan has been impacted by various natural hazards, political and economic shocks, and warfare. In that context, this study is to assess and understand the vulnerability of the Afghan people who are exposed to multiple natural and anthropogenic hazards with the use of the Pressure and Release (PAR) model, combined with the Analytical Hierarchy Process (AHP) model and a variety of data publically available for nation of Afghanistan. Assessing vulnerability is a difficult question that must go beyond analyzing the probability of a receptor (population) being exposed to hazards. Hazards are defined as natural or anthropogenic conditions which have the potential to injure, shorten the lifespan of or kill humans. However the presence of such conditions do not inherently generate a 'risk' without the presence of the population 'receptors'. People around the world employ various techniques to avoid or adapt to common hazards. The problem of understanding the variability of adaptation abilities which attenuate risk is paramount in developing a model for analyzing human vulnerability. Vulnerability in this study is defined as the exposure of a population to a specific hazard in a particular place (e.g., district), considered in the light of the population's ability to mitigate or adapt to that hazard, if there is any.

This study will analyze vulnerability of the population of Afghanistan to multiple hazards. Vulnerability analyses commonly approach this goal at one of two scales, either absolute or relative. In absolute vulnerability analysis, the product of risk (pressure) and adaptation (release) combine to quantify the vulnerability of a study area. Such systematic analyses are possible, however conducting such an analysis requires highly detailed data which is not available for this study area. Instead, we implement a method which considers available indicators of hazards to the population and rank them to understand their relative vulnerability, and compare them across each district of Afghanistan. In order to achieve this goal, we have selected a method of decision making science that allows comparison and ranking of indices which can highlight areas exposed to greater numbers and higher magnitudes of hazard. This method allows us to effectively utilize the limited data available, an imperative feature when studying an area like Afghanistan.

Data & Methodology

Study Area

The Nation of Afghanistan is completely landlocked, mountainous country located in Central Asia, with a population of approximately 33.3 million people (The World Factbook, 2016). The seismically active, rugged terrain, combined with regions exhibiting large seasonal temperature variation (average high temperature in one region is 35 degrees C in July, average low temperature in another region is -15 degrees C in January) requires the population to have developed significant survival adaptation techniques to flourish in extreme natural conditions. Afghanistan was ruled by a monarch until 1973, after which point the population has experienced a series of civil wars influenced by outside nations. Nearly 40 years of continuous conflict has resulted widespread civilian deaths, and displacement of the population either as Internally Displaced People (IDP) or as refugees. In 2015, there were an estimated 1.174 million IDPs in Afghanistan (Afghanistan Factsheet, 2015). Due to these conditions, we chose to study the vulnerability of the Afghan people to both physical and anthropogenic hazards.

Data

The data used in this study are openly available from multiple resources, such as the GIS&T Group at the Oak Ridge National Laboratory, the Global Risk Data Platform, as well as publically available data provided by the Afghan

Government. Conflict data from the Institute for the Study of War based on publically available publications provided on that organization's website (http://www.understandingwar.org/). Using district as the unit of study, we utilized the district boundaries shapefile constructed by the Central Statistics Organization of Afghanistan in 2005 utilizing 329 individual districts within Afghanistan. However, Afghanistan has changed districts to 398 in 2013 and 400 in 2014. Nevertheless, some data sources have not recognized this division yet. For that reason, when a dataset is available at the 398 or 400 district setting, we used spatial interpolation to convert data into the 329 district model. Details of the indicators used in this study and how they were derived are described below:

Table 1. Indices used in the study to assess vulnerability of Afghan people

Number	Indicator	Abbreviation	Description
1	District Control	Dist_Control	Central Government Control
2	Food Insecurity	Food_Insecurity	Economic and Physical ability to secure food
3	Earthquake	CUM_EQ_SUM_NOR	Probability of Population Exposure to Earthquake
4	Flood	Flood_Mean	Probability of Population Exposure to Flood
5	Drought	Drought_Mean	Probability of Population Exposure to Drought
6	Wildfire	Fire_Max	Probability of Population Exposure to Firee
7	Landslide	Landslide_Sum	Probability of Population Exposure to Landslide
8	Health Facility Access	Healthfacility_sum	Proximity of Health Facility
9	Transportation Network Density	TN_Density_Mean	Density of Transportation Network by District

With a large percentage of the population of Afghanistan working in the agricultural field, this indicator represents a significant hazard to stability, economic prosperity, and the health of the Afghan population. Drought data for Afghanistan was acquired from the Global Risk Data Platform website which combined an estimate of annual physical exposition to drought based on the Standardized Precipitation Index combined with population data derived from LandScanTM Global Population Database. Data then were aggregated at the district level using the zonal statistics function in ArcGIS. For this analysis the mean of drought exposure in each district is used to understand the overall risk present to the population throughout the district.

Earthquakes are a frequent event in Afghanistan, causing severe damage to infrastructure and physical danger to the population in most of eastern Afghanistan in the Hindu Kush Mountainous region. Earthquake data for Afghanistan was acquired from the Global Risk Data Platform website which provided estimates of hazard exposure to the population at four magnitudes, 5, 7, 8, & 9. For this study, data from magnitudes 5-8 will be included, as there was no estimate for any exposure to a magnitude 9 earthquake in the dataset. Earthquake vulnerability will be analyzed by combining the sum of each district score, for each of the three magnitudes for which data was compiled. This method will help identify the variations in vulnerability based on magnitude throughout the country of Afghanistan.

Flooding exposes the population of Afghanistan to hazard in two ways. Physical risk to personal safety and that of infrastructure can result in significant instability in a region following a flood event. Additionally, the economic impact of reduced crop load, and an inability to transport agricultural products to markets can exacerbate food insecurity issues and reduce personal wealth of a large portion of the population. Flood data for Afghanistan was also acquired from the Global Risk Data Platform website. The data is estimates of hazard exposure to flooding based on the Standardized Precipitation Index combined with population data taken from the LandScanTM Global Population Database. This data was then aggregated by the district level in Afghanistan using the zonal statistics function in ArcGIS. District mean flood score will be utilized to express the overall vulnerability that district experiences.

The Famine Early Warning System (FEWS) publication for Afghanistan in December 2016 described the most significant factors of food insecurity as, weakening casual labor market since 2013, ongoing conflict between various insurgent groups, and the estimated return of 600,000 Afghan refugees from Pakistan who will require assistance (Afghanistan Food Security Outlook, 2016). Additionally, vulnerability to natural hazards that might affect food production are addressed elsewhere in this study. Food insecurity is measured using both physical hazards such as drought, as well as anthropogenic hazards such as conflict, for this study we include it in our model as anthropogenic based on the

FEWS publication. This data is made available on their FEWS.net website downloadable as a shapefile. The food insecurity data for Afghanistan was acquired from the Famine Early Warning Systems Network using their IPC 2.0 Acute Food Insecurity Phase scale. This scale takes into consideration anthropogenic factors which relate to food insecurity, as well as weather patterns to develop the food insecurity scale. This data does not take into account population presence, and as such will be combined with district population data to understand the size of the population that faces food insecurity.

The statuses of district control - non-government controlled district center (i.e. controlled by Taliban or other insurgent group), district center control changed in last three years, and district center control currently disputed - retrieved from publications by the Institute for the Study of War were used as indicators in this study to assess the vulnerability to armed conflict. More specifically, we did the pairwise comparisons among these indicators to derive District Control which is a proxy for vulnerability to armed conflict. We selected this metric to express the fact that lack of government influence does not necessarily imply hazard exposure to the population. District control information was derived from publications by the Institute for the Study of War, based on analyst review of intelligence and media reports.

Following decades of deforestation and loss of biodiversity (Saidajan, 2012) wildfire events present an inordinately large risk to the livelihoods of vulnerable populations, especially impoverished families who rely on these resources as fuel to cook and heat their home. For this reason, potential wildfire exposure was included in this assessment. Data regarding exposure to fire hazard was collected by the Global Data Risk Platform and derived from estimated fire event data collected from November 1995 until March 2011. Data collected was aggregated at the district level using the zonal statistics function in ArcGIS, and the Max and Mean values will both be used for the analysis portion of this study. The goal in using both values is to understand both the areas which have the highest individual fire danger, as well as which districts as a whole are most prone to such events. This factor was included for both the physical and economic risks the population will be exposed to with the presence of a fire event.

Data regarding exposure to landslide was collected from the Global Data Risk Platform and derived from six physical parameters including: slope factor, lithological conditions, soil moisture condition, vegetation cover, precipitation and seismic conditions. These attributes were then combined with a population grid from the LandScanTM Global Population Database to express the prevalence of population at risk to landslide. This data includes both landslide as well as avalanche caused by snow, of which both types of hazards are common in Afghanistan. A recent avalanche event occurred on February 7th, 2017, in which more than 100 people were killed in a single event. For inclusion in this study data was aggregated at the district level, and the sum of the exposed population is used for analysis to understand the size of the population at risk to landslide events.

One of the main adaptation techniques being used in this study is access to health facilities. The Afghanistan Central Statistics Organization (CSO) provides health facility location data stored on the Afghanistan Information Management System website as a shapefile. For incorporation to this study, health facilities available per 10,000 district residents is calculated to give a relative availability score across the districts of Afghanistan. Results of this calculation are found in Figure #2 (all figures except #4 can be found in the appendix page at the end of this paper) and are categorized as highest access (Rank 1) to lowest access (Rank 7).

Network density data was also incorporated into this study to express the probability of delivery of aid and supplies following a hazardous event. The network data used in this study was collected by the Afghanistan CSO as a nationwide shapefile. The Transportation Network Shapefile data was converted into a line density map, and then conducted a zonal statistics function to express each district's transportation network for which the mean density score is used. Results of these calculations are found in Figure #3 and are categorized from highest density (Rank 1) to lowest density (Rank 7).

The preceding indicators were used in a decision-making analysis framework that includes the Pressure and Release Model and Analytic Hierarchy Process, which we will describe in detail in the next section.

Method

Pressure and Release (PAR) Model: The PAR model (Blaikie et al. 2014) incorporates two previously introduced aspects of vulnerability into our study to help analyze vulnerability in Afghanistan. The exposure of a hazardous condition to the population (*receptors*) combine to create risk (*pressure*). Once potential hazards were identified, aspects of adaptation (*release*) which will attenuate risk were identified and those conditions used to express mitigation of the pressures. The inclusion of pressures and releases of vulnerability provided the conceptual model for designing this study. However, the PAR model does not provide a method to compare the significance of pressures and releases, or individual hazards against each other. Here we will explain how we achieved this goal.

Analytic hierarchy process (AHP): Developed by Saaty in 1980 (Wind, Saaty 1980**),** the Analytic Hierarchy Process is a multi-criteria decision-making method which is used to structure a complex problem into a hierarchical framework and integrate qualitative and quantitative data and/or judgement across multiple criteria into ratio scale priorities to facilitate the ranking of a set of alternatives, actions, or objects. AHP has been used in various environmental studies (e.g., Smith 2003, Berrittella et al. 2007, Schmoldt 2013) as well as for conflict resolution (Saaty 2008) and resource allocation applications. AHP's ability to organize a problem into a well-structured hierarchy provides researchers the ability to more clearly describe the goals of the study to stakeholders, and develop a shared understanding. As researchers work together to develop the hierarchy, experience of multiple experts can better contribute to the goal, and allow for the comparison of numerous attributes in the study. This is achieved by conducting pairwise comparison of related indicators, by assigning a preference (in this case most or least hazardous condition) on a scale of one (equal importance) to nine (extreme importance). These weighted preferences are then utilized to develop the ratio scale ranking of criteria included in the study at each level in the hierarchy. Applying AHP in this study allows the researcher to structure the multiple hazards into a hierarchical format and to derive weights which represent the magnitude of risk (for pressures) or attenuation of risk (for releases) at each level in the hierarchy to help define vulnerability in Afghanistan. Weights derived in AHP were then used to rank relative significance of criteria within the hierarchy. Each level in the hierarchy underwent the same process to derive the overall vulnerability ranking for each district in Afghanistan to the hazards we included in this study. While this method inherently relies on subjective analysis of conditions, it has been argued that the interpretation of all data, even that on a standard scale which is considered objective, is always subjective. (Blumenthal 1977, Saaty 2008)

For this study, a six level hierarchy (Figure #4) was designed to address relative vulnerability in Afghanistan. The first level (top) represents the overall goal of the assessment which is to assess Cumulative Vulnerability of the 329 Districts in Afghanistan. The second level includes two groups of hazards being analyzed, 'Physical' and "Anthropogenic'. At this level we begin comparison between each node, and between 'Physical' and 'Anthropogenic' the assessment is made that Anthropogenic hazards (especially armed conflict) is the most significant hazard faced by humans, and especially in a war ravaged country like Afghanistan. For this reason, Anthropogenic hazards are considered significantly more hazardous, and the weight depicted in the Anthropogenic Node of Figure #4 (0.87777) is the result of this assessment. At the third level of the hierarchy, each hazard group in the second level was broken down into individual hazards with, earthquake, landslide, flood, drought, and wildfire for physical hazards and food insecurity and armed conflict for anthropogenic ones. Again, these individual hazards are compared against each other in pairwise comparisons in which the researcher identifies which factor creates greater hazard for the population of Afghanistan and calculates the weight of that difference using the AHP program Super Decisions ™. The fourth level of the hierarchy includes the pressure and release factors, if any, assigned to each hazard. Because not all hazards had identifiable release factors, this level in the hierarchy is the first point at which the model begins to become unique. The fifth level includes multiple nodes of either pressures or releases which are ranked against each other to determine their relative significance within that aspect of vulnerability. Nodes within the fifth level are depicted as either ‘Net Con’ for the indicator of Network Connectivity, and ‘H F A’ for Health Facility Access. The sixth level of the hierarchy represents the individual district’s indicators corresponding with the nodes above, by indicating ‘DIS A-Z’ to represent all districts included in this study.

Throughout the hierarchy, nodes at the same level are compared against each other with respect to a node one level higher. For this analysis, the researcher acted as the analyst and utilized his knowledge and personal experience and research of Afghanistan to conduct the pairwise comparisons in AHP. When we compared pressures and releases, pressures were always considered more important than releases, as no indicator we studied could completely offset the dangers created by hazard exposure. However, we can weigh these pressures and releases differently for different hazards. It reflects the fact that the same capability of adaptation and/or mitigation might have different impacts/influences on different hazard exposures. At the second level of the hierarchy, we considered anthropogenic hazards to be much more dangerous to human safety compared to physical hazards based on total lives lost to armed conflict (Blaikie et at. 2014). At the third level we compare individual indicators of vulnerability against each other in pairwise comparisons to develop our ranking. For anthropogenic hazards, our proxy indicator for armed conflict (district center control) was ranked above food insecurity with a strong preference. For the five physical hazards at the third level, we did five pairwise comparisons to derive their relative priorities (i.e., danger) to the population. Results from least to greatest risk were: wildfire, landslide, flood, drought and earthquake. At the fourth level of the AHP hierarchy, we compared the relative significance of pressures versus releases if any release factors were identified. If no release factor was identified, pressure nodes were assigned the full weight (1). The fifth level of the hierarchy compared the relative significance of multiple pressure or release indicators if more than one was identified. For district control, we compared the four conditions of district center control (Figure 4, Insert #1) (government control, non-government control, actively disputed control and change of control in last 3 years) to rank the relative hazard to which each condition would expose the population. Elsewhere in the fifth level, multiple release indicators were used for three of our physical hazards. Health facility access and network density were assigned as potential release mechanisms for earthquake, landslide and flood. Because the ability of health facility access and network density to attenuate risk will vary depending on the hazard being considered, these indicators were ranked against each other for each of these conditions. At the sixth level of this hierarchy, we did not carry out the trademark pairwise comparisons of AHP but utilized the ratio-scale scores of the nine indicators described earlier.

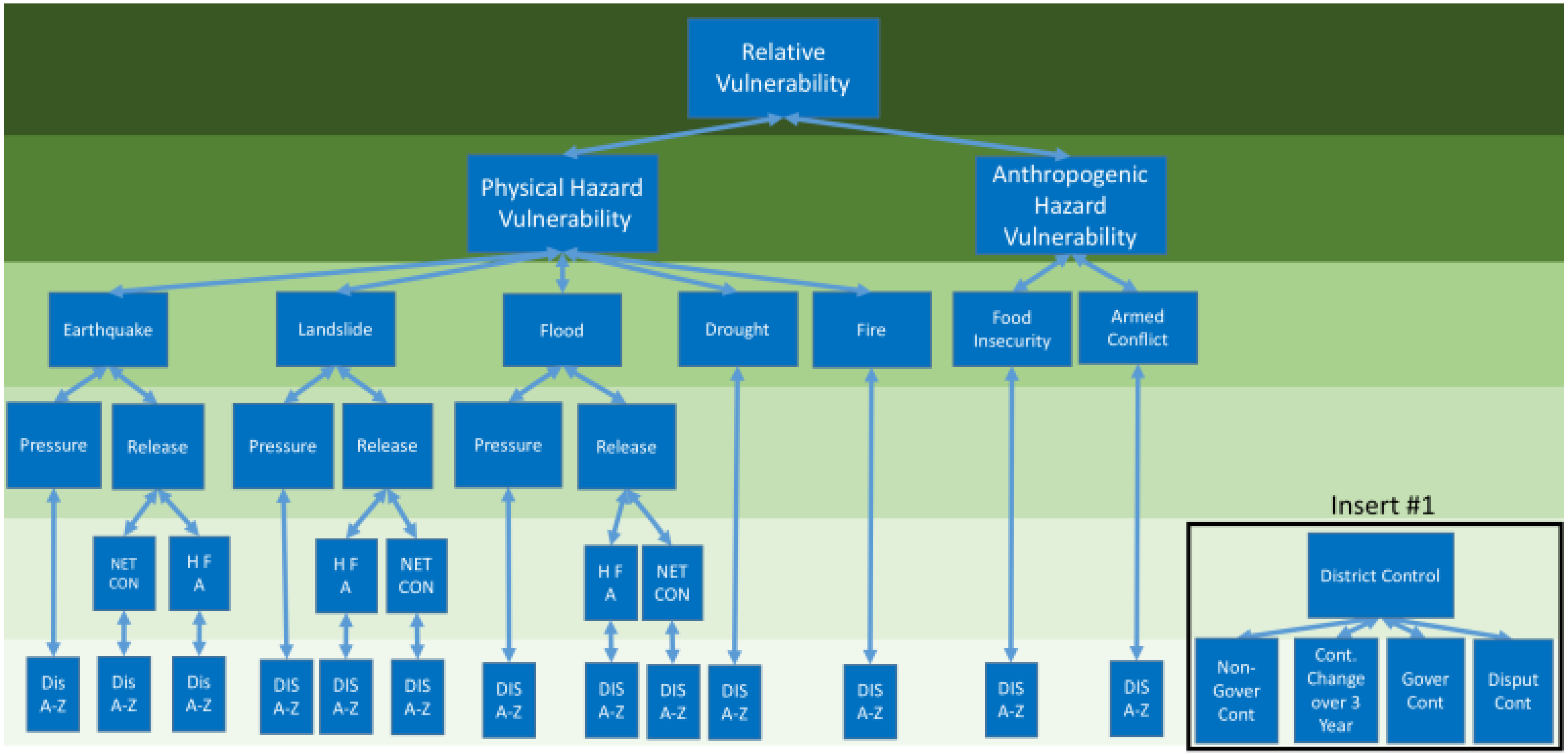

Figure 4. AHP Model to assess the vulnerability of Afghan people to Physical and Anthropogenic Hazards

Once exposure scores were calculated for each pressure and release indicator included in the study, the raw score is applied at the lowest level of the hierarchy, depicted in Figure #4 as “District A, District B, etc…” for one district with values normalized between zero (lowest exposure score) and one (highest exposure score). From there, each score is then multiplied by the weighted score of the next highest node in the hierarchy to assign the relative weight of the magnitude of exposure as was decided in the pairwise comparisons. This process continues as we progress ‘up’ AHP model, culminating in a ‘Relative Vulnerability’ score for that district.

Results and Discussion

Exposure/vulnerability to different hazards were displayed on maps with scales ranging from Rank 1 (lowest exposure/vulnerability) to Rank 7 (highest exposure/vulnerability) except in the case of categorical indicators which use fewer than 7 categories. Data was categorized using the quantile classification.

Physical Hazards

The five natural hazards included in this study aligned in patterns which were not unexpected. High levels of exposure to flood generally followed the main river basins in Afghanistan. Geologic hazards generally follow areas of high elevation and in close proximity to seismic faults. Physical hazards are ranked here from least to most significant based on rankings developed in the AHP model.

Fire is considered the least dangerous physical aspect we analyzed due to the low total exposure of fire to the population in Afghanistan. Fire shows a scattered pattern, although nearly all regions considered vulnerable to fire hazard are in desert or semi-arid climates.

Three clusters of areas with high vulnerability to landslide are observed: northeastern part of the country, the southern and western regions. A large cluster of low vulnerability exists along the northern plains adjacent to the Amu Dariya river (area #1 on map 4-b). The Kabul Valley (area #2 on map 4b) also stands out as a region of low risk, surrounded by higher risk due the Kabul Valley’s lack of significant elevation variability.

Exposure to floods (Figure 5) are most significant along the Amu Dariya river (area #1 on map 5-a) on the northern border of Afghanistan, and within the Kabul watershed (area #2 on map 5-2) in the eastern region. A third region of high relative exposure is observed along the upper sections of the Hilmand River Watershed (area #3 on map 5-2). Watersheds in this area funnel precipitation from large land masses with substantial elevation variation into relatively narrow basins. Inclusion of adaptation and/or mitigation capabilities significantly impact these clusters. The most significant change is seen in the northern districts of Afghanistan where a robust transportation network attenuates some of the flood hazard in that region. Flood events are common throughout Afghanistan due to the annual arrival of monsoon rains from the Indian Ocean, and thus the population of Afghanistan is generally well adapted to such events. Despite this, events of greater magnitude can still severely affect the safety and livelihoods of the Afghan population.

Potential exposure to drought is most common in two well defined areas of Afghanistan, the fertile northern region within the Amu Dariya River, and throughout the southern desert areas. Drought events in Afghanistan are assessed as the second most severe physical hazard to which the population can be exposed. The justification for our assessment includes several factors: the population's lack of adaptation techniques available to attenuate risk, economic reliance on agriculture and the number of impoverished groups which cannot rely on groundwater to replace surface water availability.

Areas with high exposure to earthquake hazard are in the north eastern region of the country. (Figure 7) This vulnerability closely aligns with the North/South trending Chaman fault line, and the East/West Herat transverse fault in the north of the country. However, once the capabilities of adaptation and/or mitigation were assigned the pattern of vulnerability changed and included more regions in the central part of the country. While the northeast remains the most vulnerable, this pattern can be taken to see that in the areas of significant hazard to earthquake exposure, strong adaptation techniques also exist. Earthquake was assessed the most significant natural hazard exposure to the population of Afghanistan.

Anthropogenic Hazards

In contrast to exposure to physical hazards which concentrates around the national capital of Kabul, areas of high exposure to conflict is found in remote regions away from the national capital (Figure 8). We explain this pattern given the difficulty of expanding the influence of the central government from the capital across a large and sparsely populated nation, and given the difficulty encountered by the government in responding to armed conflict in more distant locations. Of the four district control conditions considered (i.e., Afghan government controlled district center, non-government controlled district center (i.e. controlled by Taliban or other insurgent group), district center control changed in last three years, and district center control currently disputed) many of the areas in Afghanistan which have been ranked with the most severe district center control (i.e., disputed control of district) condition are along the periphery of the country. This is consistent with longstanding analyses of Taliban and other militant groups use of national boundaries to regroup and plan operations during the winter seasons, with leadership returning to Afghanistan in the spring to resume operations against the Afghan Government.

Food insecurity (Figure 9) also shows a strong presence away from Kabul, and especially in regions with a low transportation network density. This lack of connectivity causes difficulty in acquiring food during periods of food stress.

An additional observation is that it is also evident many of the most vulnerable districts in Afghanistan are primarily settled by non-Dari speaking ethnic groups, and most frequently by people from the Pashtun ethnicity. The ethnic divide in Afghanistan remains one of the most significant impediments to national unification, and this pattern shows an increase in vulnerability among populations of the non-majority ethnicities in the country. It is also important to note that the Taliban came to popular power in southern city of Kandahar in the 1990's, the second largest city in the country which is considered the "spiritual capital city of the Taliban." Although the city of Kandahar (area #1 on map 8-b) actually remains relatively stable, in large part due to the resources leveraged in the city by the national government, nearby districts show significant vulnerability to anthropogenic hazards as the Taliban continues to compete with the central government for influence in this region. With the national capital located centrally in the Dari speaking region of Afghanistan, along with the longstanding difficulty of recruiting Pashtun natives into the Afghan military and intelligence communities, the government of Afghanistan continues to face significant difficulties in reducing regional armed conflict.

Cumulative Vulnerability

The patterns of physical and anthropogenic hazard occur in dissimilar clusters throughout Afghanistan (Figure 9). However, the districts in Afghanistan that do experience relatively high exposure to both physical and anthropogenic hazards will have the highest level of vulnerability in the country. The clear result of this study is that in both aspects of vulnerability we explored, the population around the national capital was exposed to high hazards, and thus remains one of the most vulnerable places in the country.

Overall, no single district in Afghanistan was assessed to have a high exposure to all physical hazards based on our ranking system. However, we do see a clear pattern of overlapping vulnerability to two types of physical hazards, atmospheric (flood, drought, fire) and geologic (earthquake, landslide). Based on our ranking hazards as most and least significant, the districts which display the highest physical vulnerability ranking are mostly exposed to hazardous geological conditions in the east and north of the country. There is one cluster of districts (area #1 on map 9-b) identified in the extreme high elevation region as highly vulnerable. This cluster contains 21 adjoining districts ranked in the top two most vulnerable categories of this study. The combination of rugged terrain and lack of mitigation capabilities in this area account for the presence of this pattern.

In contrast to the results of physical hazard exposure, districts in Afghanistan experience high anthropogenic vulnerability (Figure #11) in a nearly random pattern, with only small clusters of high anthropogenic vulnerability found throughout the country. Throughout the country (areas #1, #2, #3 on map 14), clusters exist of between two and five directly adjoining district that are ranked in the top two most vulnerable categories. Such small clusters of anthropogenic vulnerability cause a much more difficult response by the central government.

Conclusion

Key points we wish to highlight with this study are summarized as:

- Anthropogenic vulnerability (to food insecurity and to armed conflict) have similar spatial patterns (e.g., high vulnerability in similar areas and the like for low vulnerability), and we observe a large gap in scores between most and least vulnerable districts.

- No single district shows high cumulative vulnerability to all physical hazards considered in this study, however clusters can be observed for the two sub categories identified in that group. Vulnerability to hazards associated with weather patterns (flood, drought, fire) cluster in similar locations, as does vulnerability to geological hazards (earthquake, landslide).

- Adaptation/mitigation capabilities studied show a clear reduction in vulnerability ranking to many of the districts in Afghanistan. Some districts with lower cumulative hazard exposure were shown to increase in vulnerability due to a lack of adaptation/mitigation techniques.

This paper assessed the cumulative vulnerability across the 329 districts in Afghanistan by combining previously utilized conceptual and operational models. The PAR model was instrumental in designing this vulnerability study as it provides mechanisms to understand how each district can respond in unique ways to attenuate hazardous conditions. The analytic hierarchy process provides a mechanism for assigning relative weights to individual aspects of vulnerability, allowing the researcher rank the significance of each pressure and release. Applying the ranks derived, our analysis shows clear clusters of exposure to greater relative hazards.

The results of this study can help both institutions within the Government of the Islamic Republic of Afghanistan, as well as outside agencies and aid organizations which aspire to support the future improvements of safety to the population of the region. By developing a better understanding of the living conditions of the population of Afghanistan we can begin to understand how addressing vulnerabilities can support future stability within the country and region.

CONCLUSION

This paper explored the relative vulnerability of the people of Afghanistan under multiple physical and anthropogenic hazards to which they are exposed. By incorporating the Pressure and Release (PAR) model of vulnerability analysis, with the Analytic Hierarchy Process, we developed a cumulative vulnerability assessment for the 329 districts in Afghanistan. Here we revisit the initial thesis statements, review our key findings and discuss use of these methods.

Study Goals

1. How vulnerable is the population across Afghanistan with respect to multiple natural and anthropogenic hazards/risks?

    a. *How are districts across Afghanistan more or less vulnerable compared with others with respect to multiple hazards/risks?*
    b. *Given a large set socio-demographic indicators, is there a way to assist a stakeholder in analyzing vulnerability while taking into account her/his unique perspective/value?*

2. Given the results of this analysis, is there a way to assist policy makers in identifying plausible actions to reduce vulnerability in the populations at greatest risk?

In this study, we chose to analyze human vulnerability to natural and anthropogenic hazards at the district level in Afghanistan. Our first decision point was choosing whether to pursue a study of absolute or relative vulnerability, and due to the limits of data available for Afghanistan the decision to conduct a relative vulnerability analysis was made. Using common indicators across the country, allows us to understand their relative significance when discussing vulnerability. Because these indicators do not explain every hazard or living condition that exists in Afghanistan, it would not be possible to address vulnerability at the absolute scale.

However AHP can also be implemented with a large number of stakeholders provide their unique experience to help inform and refine the study. This is accomplished through the incorporation of the Analytic Hierarchy Process, in which as many stakeholders as is desired can assign their own ranking to indicators of vulnerability and help refine the results. Using a single stakeholder as the analyst, we arrived at the following conclusions:

Key Findings

- Anthropogenic vulnerability to food insecurity and to armed conflict have similar spatial patterns (e.g., high vulnerability in similar areas and the like for low vulnerability), and we observe a large gap in the values between most and least vulnerable districts.

- No single district shows high cumulative vulnerability to all physical hazards considered in this study, however clusters can be observed for the two sub categories identified in that group. Vulnerability to hazards associated with weather patterns (flood, drought, fire) cluster in similar locations, as does vulnerability to geological hazards (earthquake, landslide).

- Adaptation/mitigation capabilities studied show a clear reduction in vulnerability ranking to many of the districts in Afghanistan. Some districts with lower cumulative hazard exposure were shown to increase in vulnerability due to a lack of adaptation/mitigation techniques.

A final goal of this study was to assess how, if at all possible, this study could be utilized by decision makers to address areas experiencing high vulnerability to the hazards we investigated. As short term response, this analysis can help identify areas underserved by medical attention, and help emergency responders prioritize aid response to those districts. This assessment can also be used to inform future policy decisions regarding the expansion of the transportation network to mitigate future hazardous conditions. In the future, incorporating policy makers unique backgrounds and perspectives, as well as the perspectives of a wide range of Afghan locals, can further refine this analysis and support the reduction of injury or loss of life to natural and anthropogenic hazards.

With the continued engagement in the longest war in the history of the United States of America, and the 2016 reversal of previous U.S. Military personnel reductions, the future stability of the Islamic Republic of Afghanistan remains an important and uncertain geopolitical question and a significant concern for the population of Afghanistan. The current conflict is only a continuation of armed conflicts which have raged nearly continuously for 40 years. Throughout the course of this most recent conflict, the U.S. Military proposed and implemented new counter insurgency techniques, and old methods were dusted off and refined for use. Three of the main tenets of General Petraeus' Counterinsurgency doctrine, as described in the U.S. Army Field Manual 3-24 "Counterinsurgency"(Counterinsurgency 2006), include ensuring robust Essential Services, Governance, and Economic and Infrastructure Development. The provision by a national government of these aspects are considered vital by the U.S. Military to ensuring the legitimacy of a government by the population they serve, and maintaining a stable country free from armed conflict. Despite these ongoing efforts, the population of Afghanistan continues to be exposed to widespread armed conflict at the hands of insurgent groups. According to the World Health Organization, the population also continues to display high levels of infant mortality and low life expectancy, much of which can be attributed to the inability of the Government of Afghanistan to provide an adequate capacity of the aforementioned vital services. In addition to frequent exposure to conflict, the population of Afghanistan experiences a high rate of exposure to natural hazards which can physically harm their population, or destroy the livelihood on which those families rely. When hazardous conditions exist, the government must respond quickly to support their citizens, or face continued opposition by insurgent actors (Garfield 2015). Lack of an adequate response by the government provides valuable propaganda to those who seek to undermine their legitimacy. Based on these considerations, assessing the vulnerability of the population of Afghanistan is important for both the central government, as well as outside organizations which strive to reduce conflict and increase stability in this region.

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APPENDIX

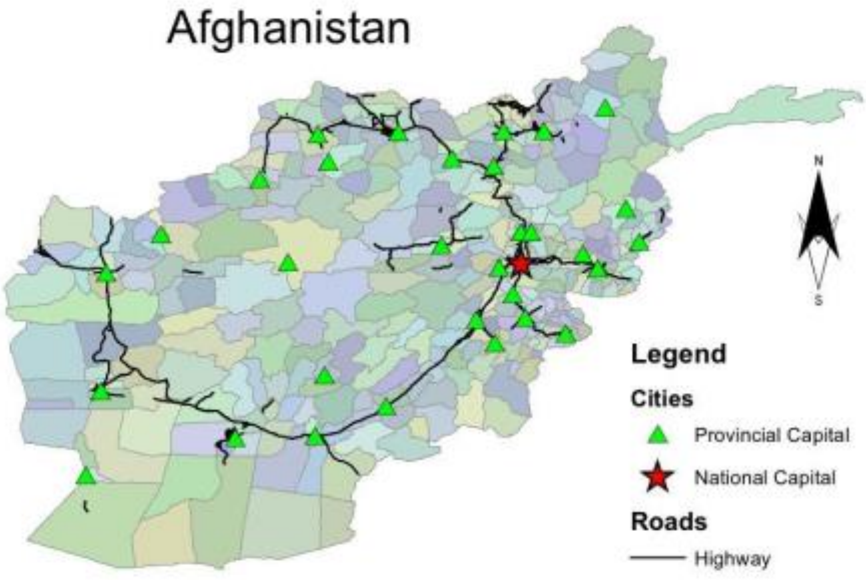

Figure 1. Study Area Map

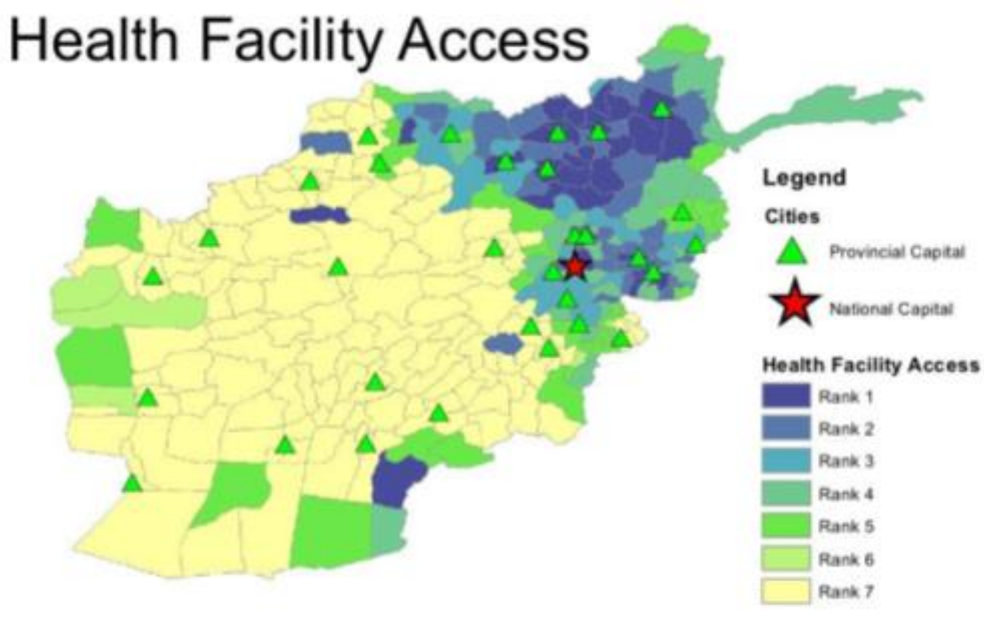

Figure 2. Health Facility Access

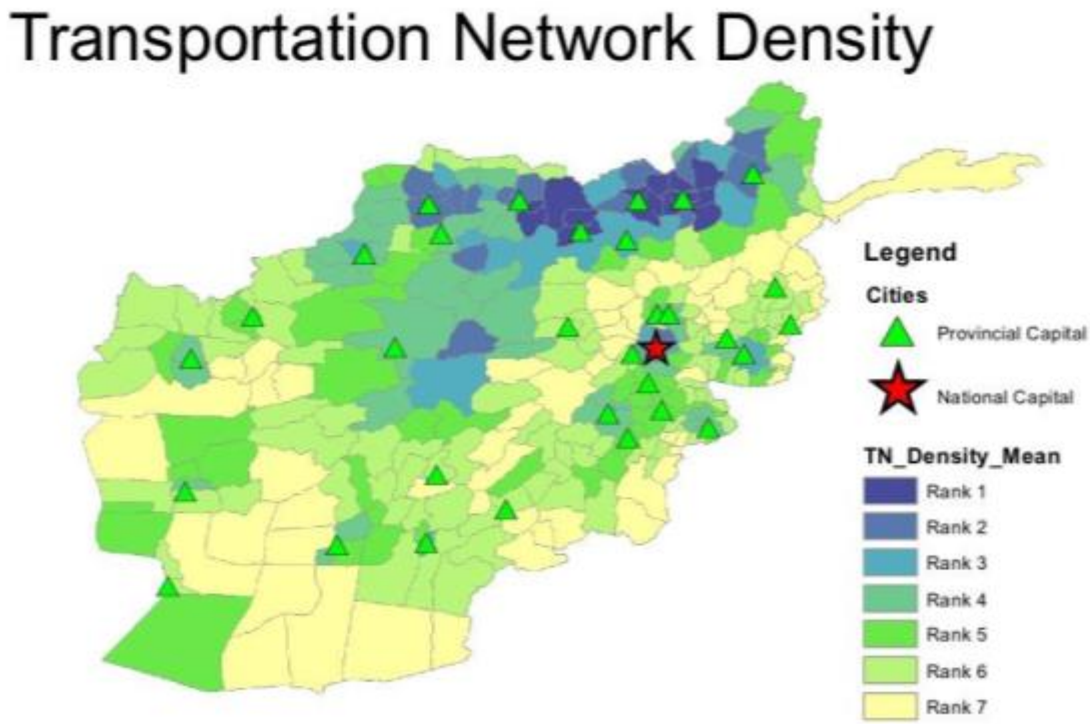

Figure 3. Transportation Network Density

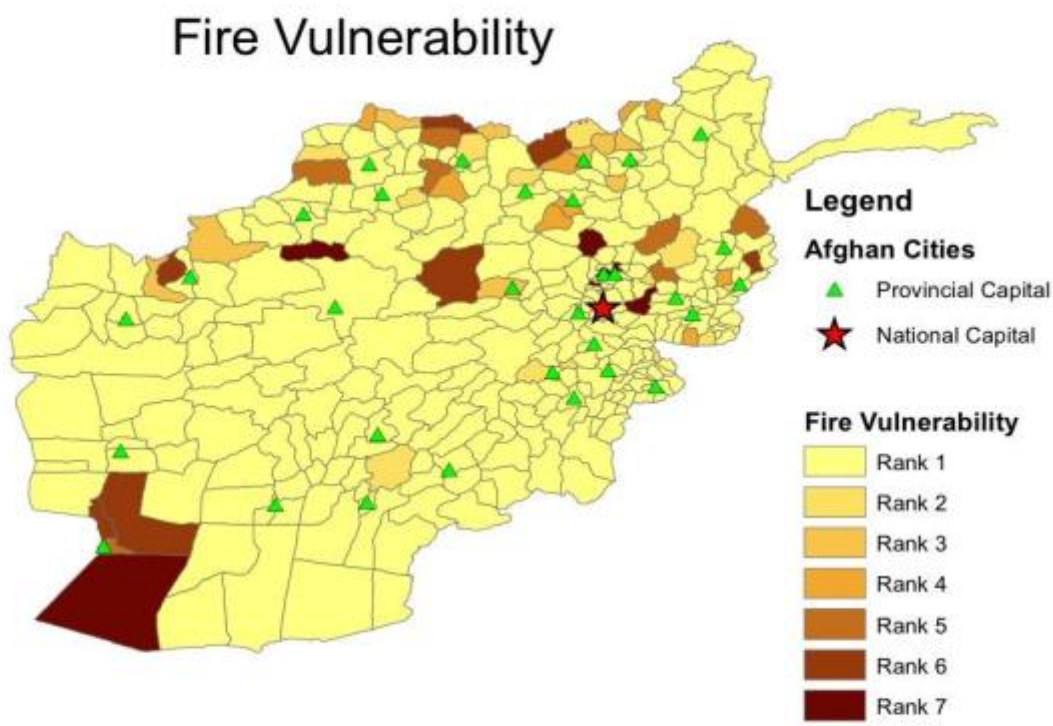

Figure 5. Fire Vulnerability

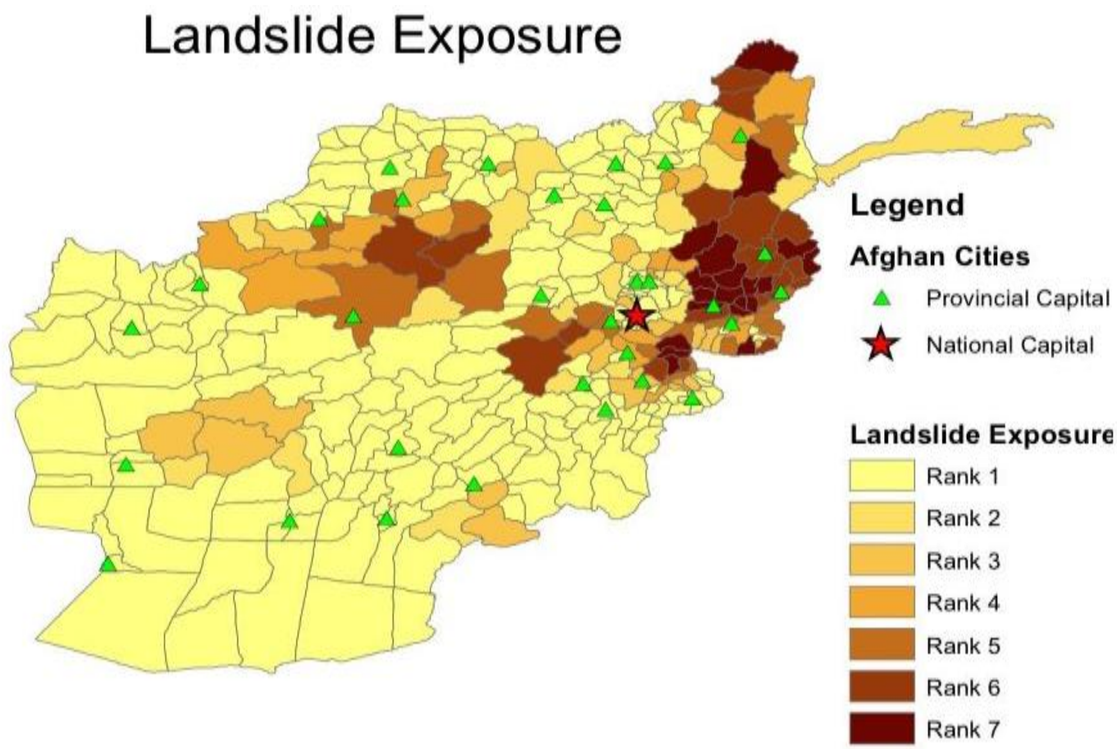

Figure 6. Landslide Exposure

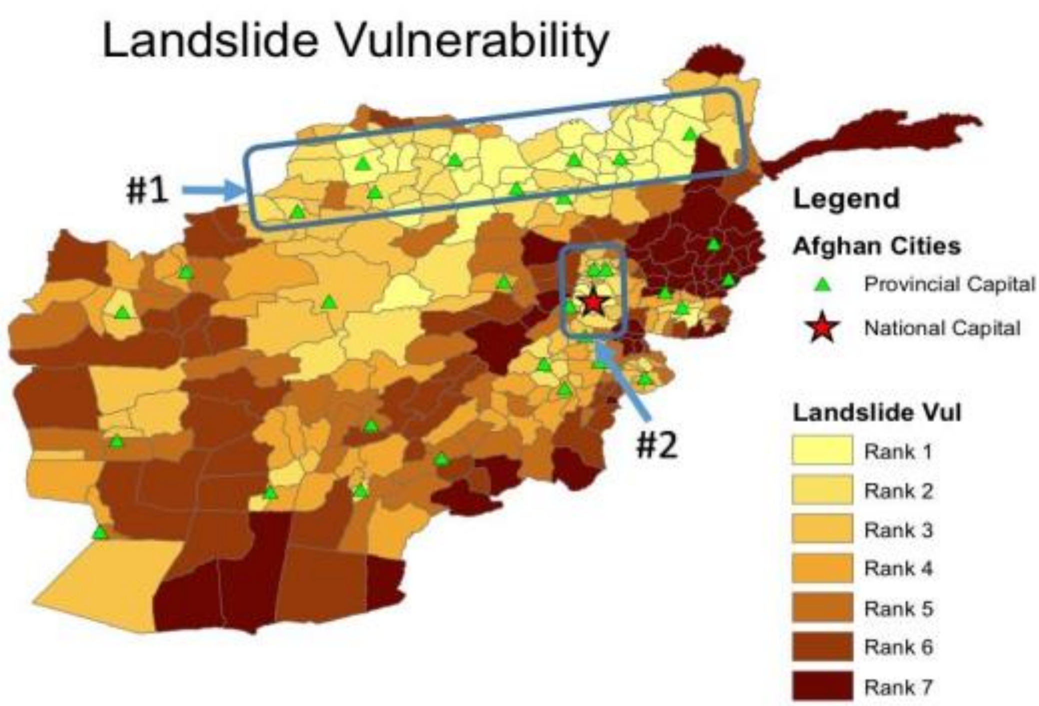

Figure 7. Vulnerability to Landslide

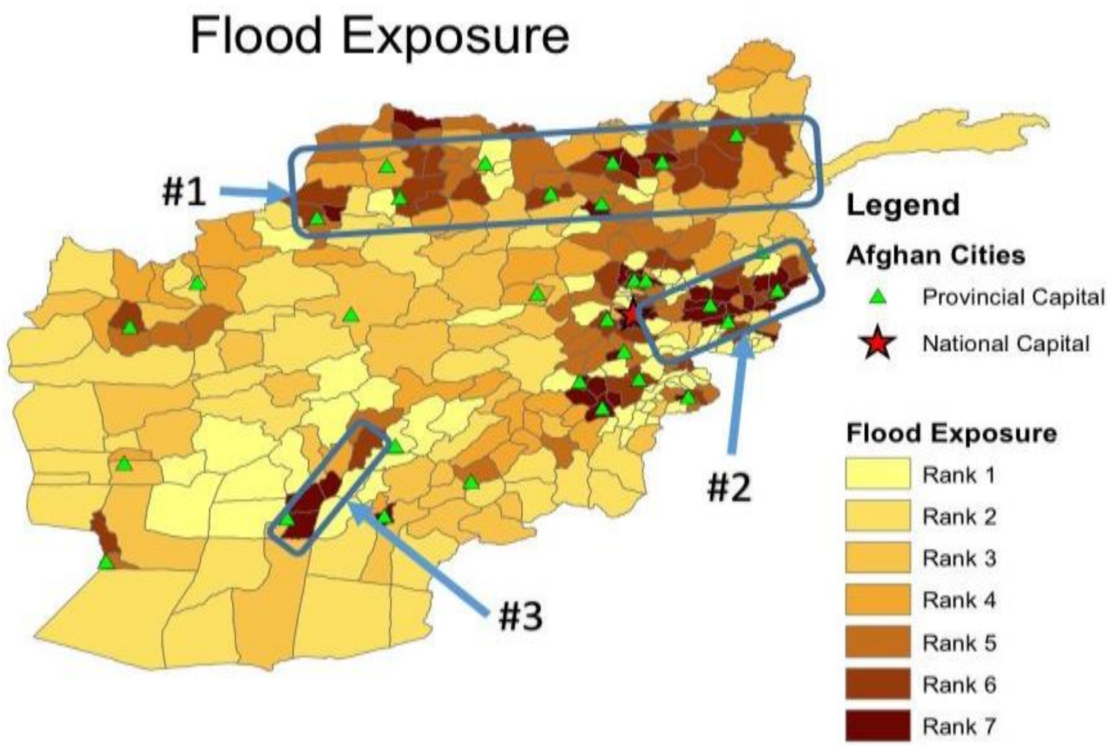

Figure 8. Flood Exposure

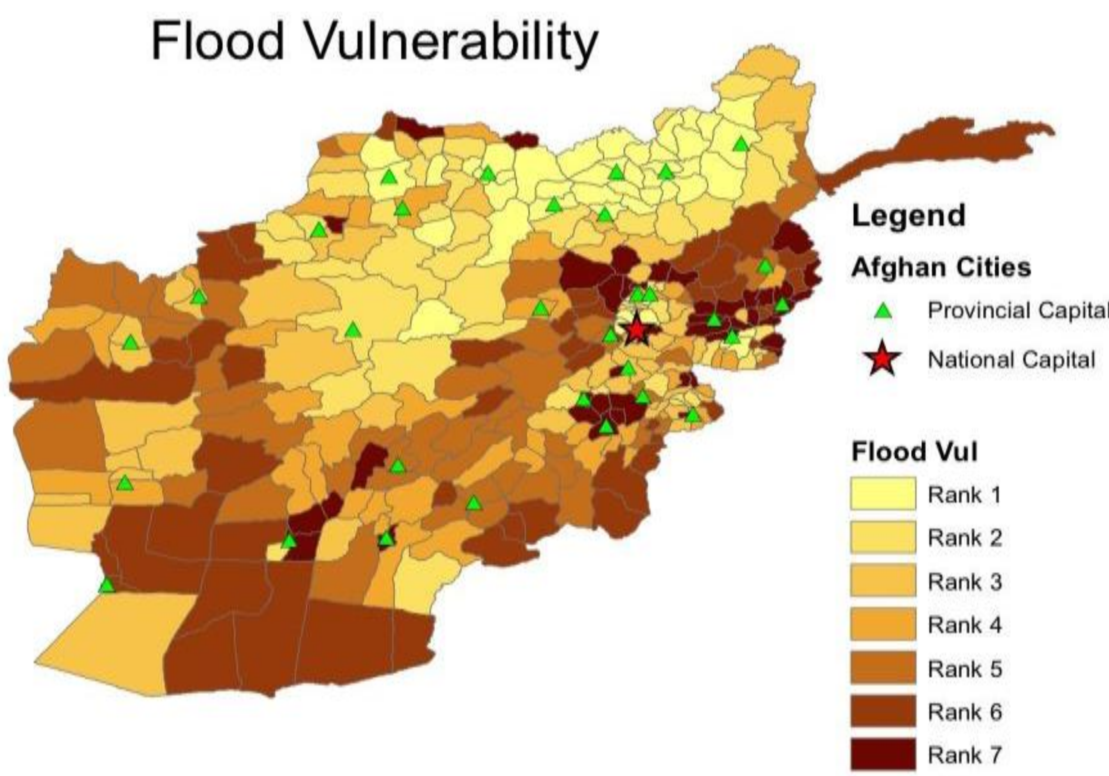

Figure 9. Vulnerability to Flood

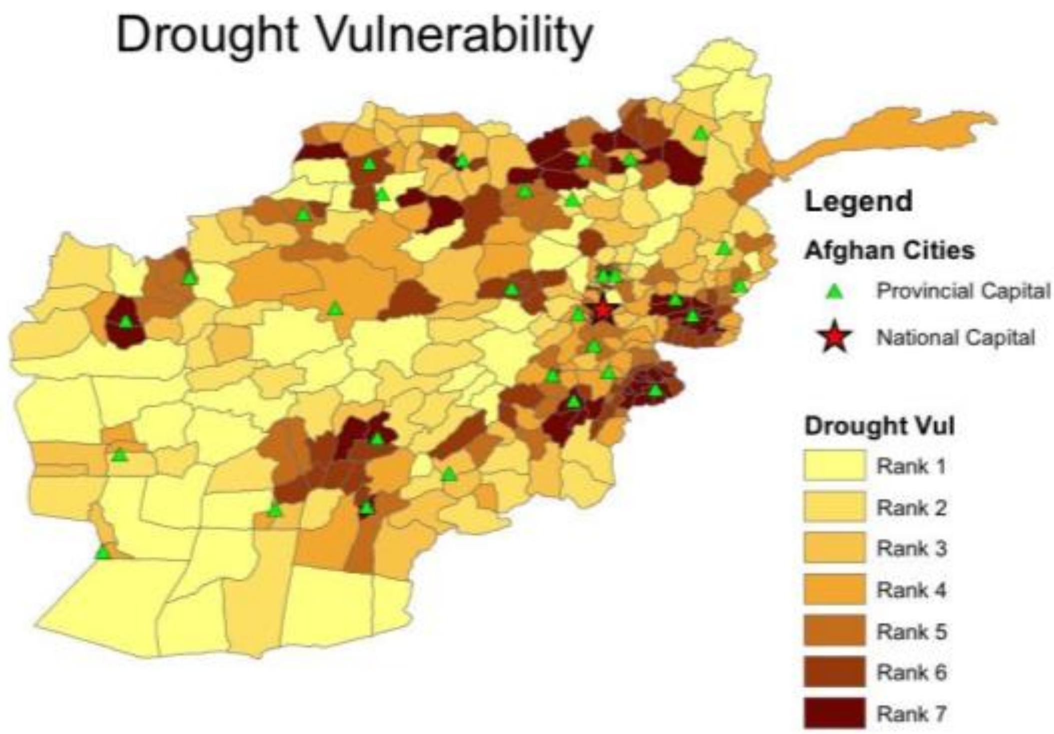

Figure 10. Vulnerability to Drought

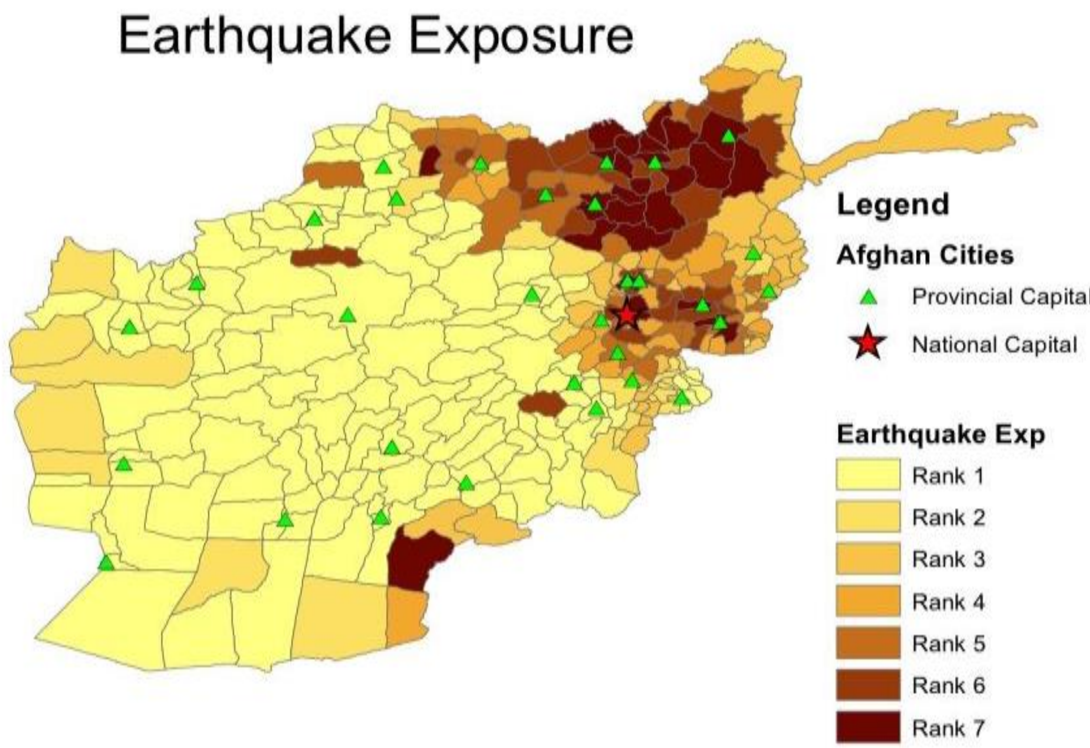

Figure 11. Earthquake Exposure

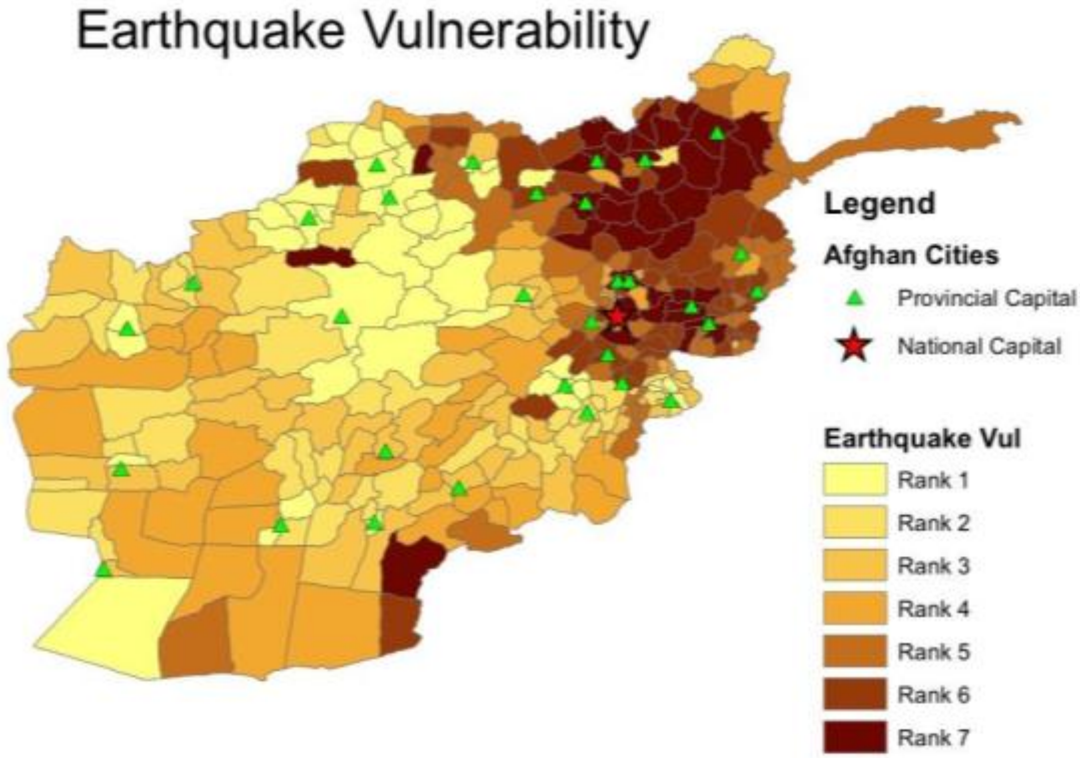

Figure 12. Earthquake Vulnerability

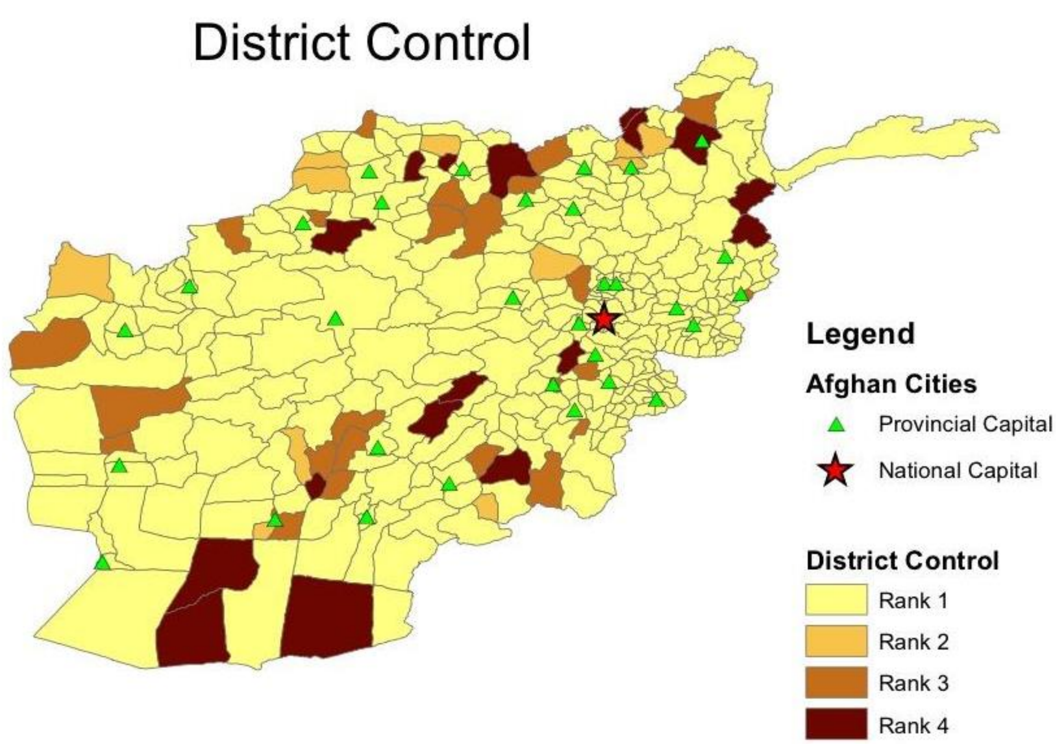

Figure 13. District Control (Proxy for Vulnerability to Armed Conflict)

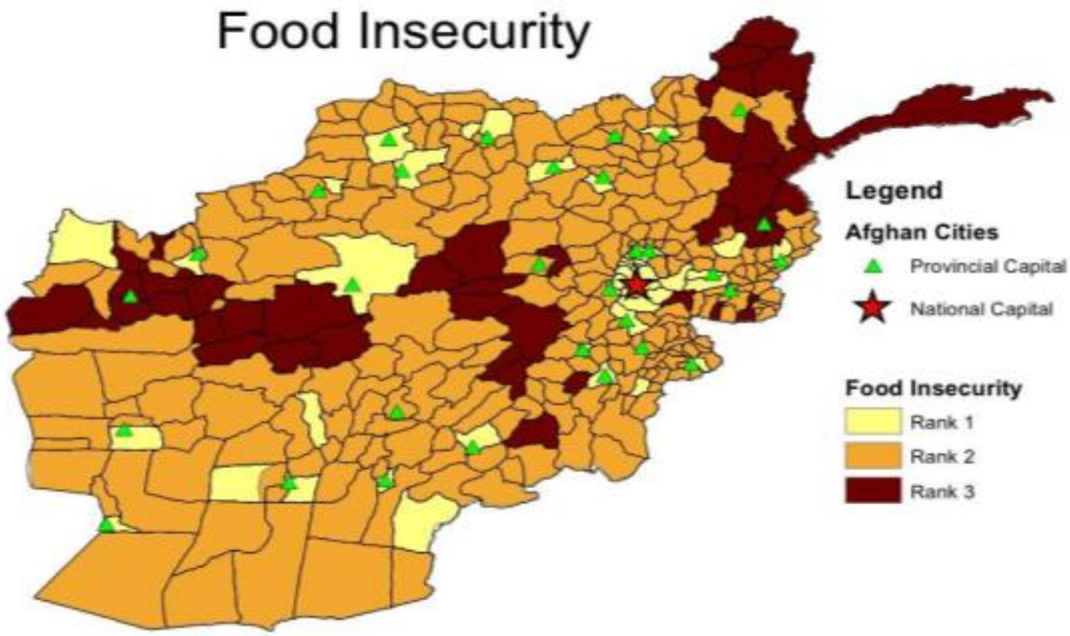

Figure 14. Vulnerability to Food Insecurity

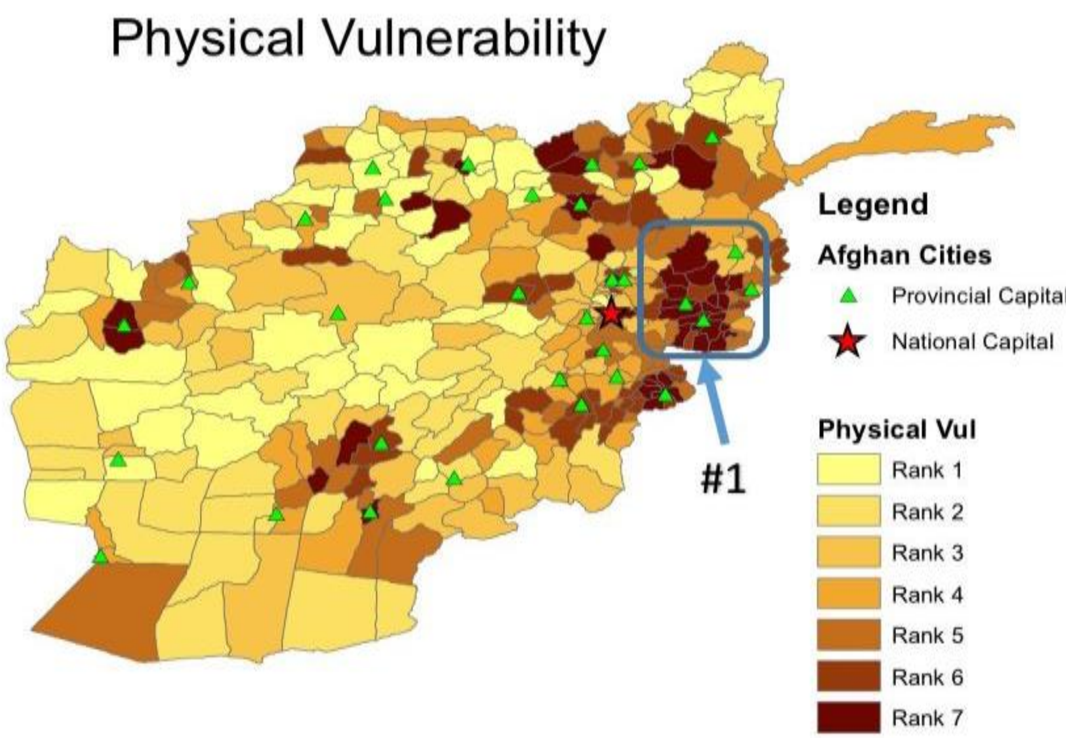

Figure 15. Vulnerability to Physical Hazards

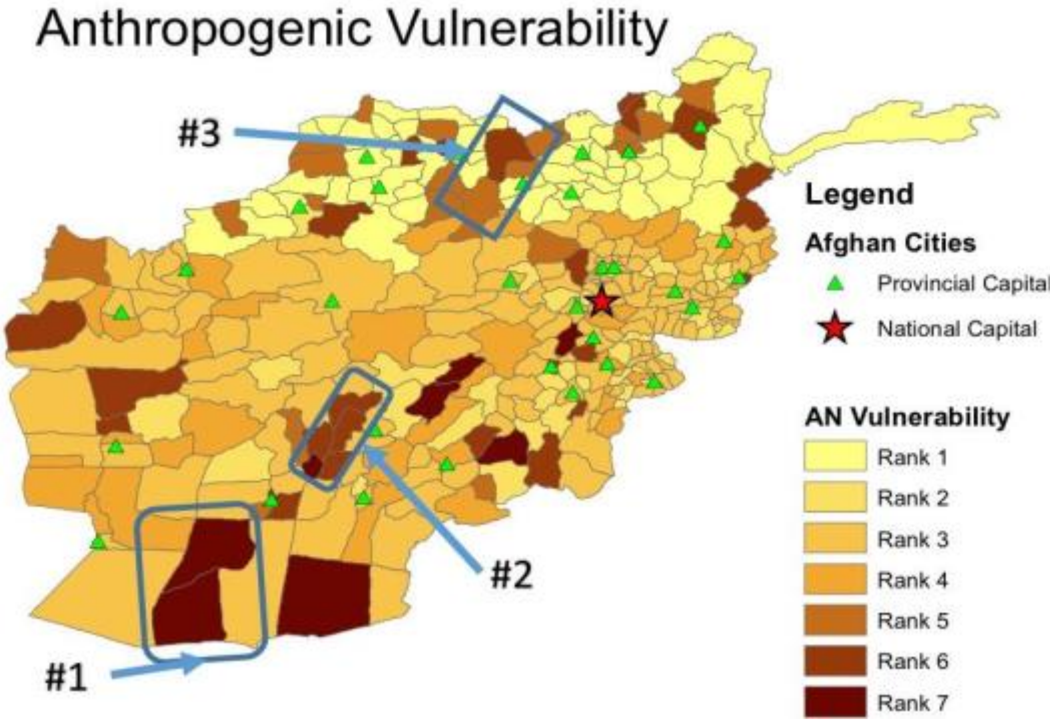

Figure 16. Vulnerability to Anthropogenic Hazards

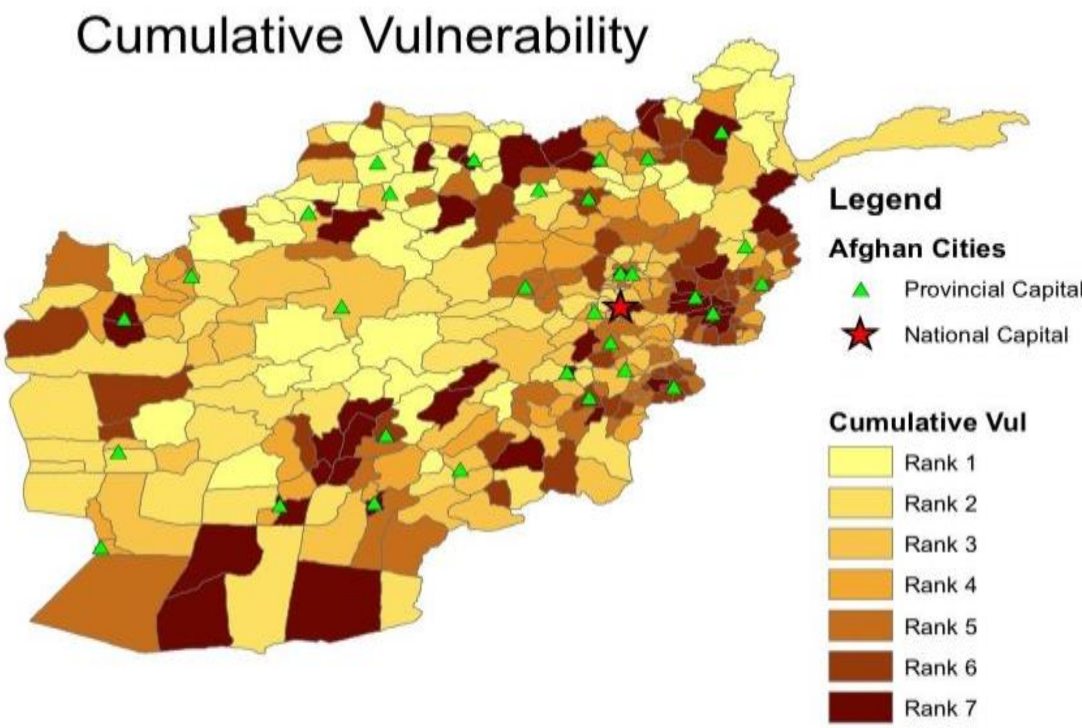

Figure 17. Cumulative Vulnerability

VITA

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