

Military Response to Natural Disasters: The Resilience of Affected Nations

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Abstract

Humanitarian response efforts are difficult to predict because many variables impact the final decision. Previous research on the topic of military assistance has focused on the strength of the cyclone or earthquake as the dominant factor. The kinetic force behind a natural disaster is important, but many other elements influence a request for aid from the United States. Resilience factors such as the infrastructure's ability to withstand the disaster impact the nation's ultimate decision to request external help. If local structures and support instruments are robust enough, additional assistance will not be necessary. This paper analyzes 40 years of the United States military humanitarian response; over 300 military operations were reviewed and coded based on the nature of the disaster and the impacted country's Bundhis Entwicklong Hift WorldRiskIndex exposure, susceptibility and coping capacity values and FM Global Resilience Index natural hazard risk quality value. The research shows foreign countries will likely request the United States military aid if they have an exposure value greater than 26.3. The results of this study will assist military commanders in defining response requirements and aligning operational plans with the most vulnerable populations.

Keywords: military, humanitarian response, natural disaster, vulnerability, earthquakes, cyclones

1. Introduction

1.1 Background

Humanitarian response efforts are difficult to predict because many variables impact the final decision to deploy forces. In a previous study (Long, 2020), the United States military's response to natural disasters was evaluated by completing a 40-year analysis of humanitarian aid. The results provided military commanders the capability to predict government response for future earthquakes and cyclones based on the strength of the event. While the kinetic force behind a natural disaster is important, many other elements influence the request for aid from the United States. This paper expands on that research by examining the vulnerability of the impacted nations rather than the power of natural disaster. The analysis starts with a historical summary of resilience and its relationship to humanitarian response. Then, military responses are evaluated to determine the impacted nation's exposure and risk, susceptibility and structural vulnerability, and coping capacity. Resilience factors such as the region's infrastructure or the government's capacity to assist its citizens impact the nation's ultimate decision to request external help. If a country's local structures and support instruments are robust enough, outside assistance will not be necessary.

1.2 Resilience Versus Vulnerability

A detailed understanding of a community's resilience will shed light on their vulnerabilities and help determine the requirement for external assistance. A 7.4 earthquake in Juba, the capital of South Sudan, will likely require more external support than in The Hague, Netherlands—a similar size city with respect to population (World Population Review, 2022). The Hague is more resilient based on the Hollings' original definition, "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationship between populations or state variable" (Hollings, 1973). Life in South Sudan would be devastated after the earthquake, as the country does not have the infrastructure in place to reduce the impact of the disaster or the emergency response facilities available to aid a population in need. South Sudan is used as an example because this population is particularly vulnerable, which is different from a lack of resilience. South Sudan has an estimated 1.25 million people who are on the brink of starvation, often just eating wild plants and dry-roasted

cow's blood (Mednick, 2018; Pflanz, 2018). Vulnerability is an inherent characteristic of a population that exists pre-event, making them more susceptible to harm (Adger, 2006). This differs from resilience which is the ability of a population to “respond and recover from disasters and includes those inherent conditions that allows the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that facilitate the ability of the social system to re-organize, change, and learn in response to a threat” (Cutter et. al., 2008). Resilience considers the vulnerability of the population and their ability to control and manage the effects of the event, while vulnerability alone is an assessment of the population's pre-disaster capabilities.

It is possible to examine a nation's vulnerability through many dimensions such as infrastructure, geography, and demographics. All cities are vulnerable to a nuclear attack, but a 7.0 magnitude earthquake will not decimate every community. San Francisco sells condos which are designed to withstand earthquakes with magnitudes as large as 8.0 on the Richter scale (Lucas, 2018). Building safety, commonly assessed by the age of the building, number of stories, and construction type, is a vital indicator of the seismic vulnerability of a nation's infrastructure (Sungay et. al., 2012). There are many geographical elements, such as floodplain levels and fault line locations, which impact the risk for a community. The geographic factors do not need to be natural; human-made elements can also be a risk for the populations—such as the levee system failure that caused the flooding in New Orleans after Hurricane Katrina (Brinkley, 2015). Demographics are another factor that influence the recovery effort; young children and elderly members in the affected area require unique caregiving which depletes the available labor pool for the recovery workforce. These are just a few of the many factors that help define the resilience of a region.

A country's resilience is estimated by examining the many elements that create the society. The government must be stable and generate a culture of ex-ante preparedness in the community—from construction infrastructure to developing regulations that address vulnerabilities. After a disaster hits, the citizens need to be able to quickly cope with the shock and immediately move toward action using existing instruments to channel resources to those in need. To promptly move towards recovery, the businesses must be innovative adjusting where necessary to solve problems and finding ways to get the affected population back to work (Patel & Bibeau, 2017). There are three well-known models that estimate the resilience of a population.

1.3 Resilience Models- City Resilience Index

Many different models examine resilience, but only a few compare and index areas around the globe. When examining urban areas, the Rockefeller Foundation funded City Resilience Index is arguably the most robust assessment available. This tool evaluates cities on health and well-being, leadership and strategy, infrastructure and ecosystems, and the economy and society. This model displays the qualitative resilience performance of the region based on 12 specific goals. The City Resilience Index is a graphical display which uses red, amber, and green to display the achievement level for each goal. For example, Arusha, Tanzania shows critical gaps, denoted in red, in comprehensive security and the rule of law. While the City Resilience Index does an excellent analysis of a single urban area, both FM Global and Bundnis Entwicklung Hift (BEH) evaluate the overall resilience of a country.

1.4 Resilience Models- FM Global Resilience Index

The FM Global Resilience Index has a business slant in its evaluation of 130 nations examining economics, supply chain, and risk quality. These three factors are further broken down into four unique drivers, displayed in table 1. The FM Global Resilience Index ranked Denmark most resilient in 2021 for the high quality of its infrastructure, stable political situation, low corruption, and economic productivity (FM Global, 2021a). Haiti was on the opposite end of the scale ranking 130 out of the 130 countries evaluated (FM Global, 2021a). This nation struggles with limited financial capabilities, massive exposure to natural disasters, and poor infrastructure. The resilience of a society is a critical element when determining the requirement for outside assistance following a natural disaster.

Table 1. FM Global Resilience Index factors and drivers (FM Global, 2021b)

Economic	Supply Chain	Risk Quality
Productivity	Supply Chain Visibility	Inherent Cyber Risk
Political Risk	Local Supplier Quality	Fire Risk Quality
Oil Intensity	Quality of Infrastructure	Natural Hazard Risk Quality
Urbanization Rate	Control of Corruption	Exposure to Natural Hazards

1.5 Resilience Models- BEH WorldRiskIndex

The BEH WorldRiskIndex evaluates countries from a more humanitarian perspective. Each state is measured concerning two spheres of influence—natural hazards and societal (Bundnis Entwicklung Hift, 2021a). The natural hazard sphere assesses a countries risk for future disasters such as drought, earthquakes, and floods. This sphere is also called “exposure” and is the nation’s risk based on how susceptible the land is to prospective natural disasters. Haiti has a much higher exposure value than Denmark based on the cyclone activity caused by warm waters and Haiti’s proximity to seismic fault lines. The societal sphere examines a nation’s vulnerability by gathering data on 27 indicators that describe the society’s susceptibility, adaptation, and coping mechanism (Bundnis Entwicklung Hift, 2021a). Susceptibility is the nation’s likelihood of suffering harm following an event. Its major indexes include housing conditions, poverty, the percentage of children and elderly, and economic capacity. Adaptation is the country’s long-term plans and goals for societal change. The value is calculated by combining scores for gender equality, education, and investment in public health and ecosystem protection. Adaptability has a long-term impact on a society’s resilience but is not hugely relevant concerning immediate natural disaster response. Coping capacity is a community’s ability to recover from a catastrophe by quickly mitigating the harmful elements caused by a disaster. The driving factors behind this calculation include the fragile state index score, disaster preparedness, and medical services. The BEH WorldRiskIndex overall value is calculated by weighing and multiplying all the indicators that define susceptibility, adaptability and copying values with the nation’s exposure score. Figure 1 displays the final value formula including the individual weights for each factor.

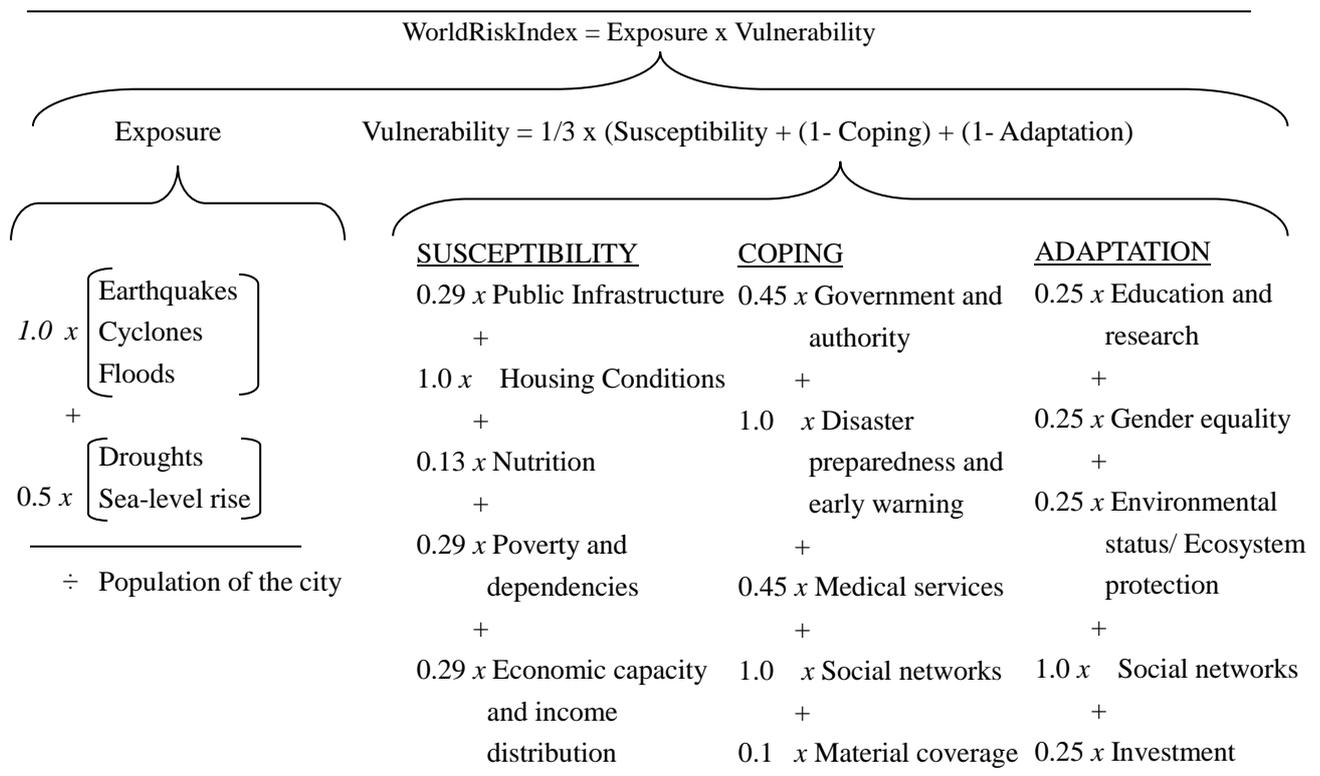


Figure 1. Calculation of BEH WorldRiskIndex overall risk (Adapted from Bundnis Entwicklung Hift, 2021b)

1.6 Hypotheses

This study will examine the military response to natural disasters while focusing on the resilience of affected nations. The fundamental belief behind the following hypotheses is that less resilient nations are more likely to need external assistance. There is no specific value that defines a less resilient nation, so this study uses the mean of countries in the high and very high quintile. The following hypotheses will be evaluated:

Hypothesis 1: The mean country exposure level, as measured by the BEH WorldRiskIndex exposure score, for countries requiring military response, will be greater than mean of countries in the high and very high quintile.

H_{01} : Exposure $\mu \leq 23.92$

H_{a1} : Exposure $\mu > 23.92$

Hypothesis 2: The mean country sustainability level, as measured by the BEH WorldRiskIndex susceptibility score, for countries requiring military response, will be greater than mean of countries in the high and very high quintile.

H_{02} : Susceptibility $\mu \leq 46.30$

H_{a2} : Susceptibility $\mu > 46.30$

Hypothesis 3: The mean country structural vulnerability level, as measured by the FM Global Resilience Index Natural Hazard Risk score, for countries requiring military response, will be less than mean of countries in the high and very high quintile.

H_{03} : Structural Vulnerability $\mu \geq 11.85$

H_{a3} : Structural Vulnerability $\mu < 11.85$

Hypothesis 4: The mean country coping capacity, as measured by the BEH WorldRiskIndex lack of coping capacity score, for countries requiring military response, will be greater than mean of countries in the high and very high quintile.

H_{04} : Coping Capacity $\mu \leq 83.86$

H_{a4} : Coping Capacity $\mu > 83.86$

2. Method

2.1 Military Response Events

The world can expect thousands of earthquakes and almost one hundred tropical cyclones each year (IRIS, 2011; Ramsey, 2017). The United States military would not be required or have the manpower to respond to all of these events. For the military to respond, there must be a significant amount of destruction and human suffering. The United States government has not established a humanitarian deployment criterion; each event is individually examined based on the population impacts, ability to respond, and political factors. To get a better understanding of the climatological or man-made factors that created the situation requiring military assistance, a complete review of the Humanitarian Service Medal historical records was needed. These records are a clear document of the military's involvement in large humanitarian aid events.

The Humanitarian Service Medal was created in 1975 to award individuals, as part of a coordinated Department of Defense response, for taking part in a significant humanitarian act (Powers, 2019). The medal has been approved for over 300 military operations. The activities include a diverse range of support including mass refugee migrations, regional conflicts, famine relief, aircraft disasters, along with assistance to a variety of natural disasters. This study specifically examined the Humanitarian Service Medal records from 1975 up to and including 2018 (HSM- Approved Operations, 2020). The researcher coded each incident by the type of event and the location of the response at the country level. Response efforts were combined into a single occurrence if the government awarded multiple medals for the same episode. The response disaster events include earthquakes, tropical cyclones, tsunamis, floods, droughts, winter storms, tornados, volcano eruptions, fires, famines and other. The "other" category includes all non-natural events, as well as unknown events that had a description that was too vague to be coded. This study only focused on cyclones, floods, and earthquakes, which made up the vast majority of the events. This study will not include events in the United States which required military assistance. The exclusion of these data will give a focused examination on the characteristics of foreign countries impacted by disasters. To better understand the military humanitarian assistance requirements, resilience needs to be examined from four specific perspectives: exposure, susceptibility, structural vulnerability and coping capacity.

2.2 Exposure

The element of exposure estimates the likelihood that a country will be impacted by a future natural disaster. A country that is straddling a seismic fault line has a high level of exposure to upcoming earthquake damage, potentially requiring external support. The BEH WorldRiskIndex captures the exposure level for each country ranking the island nations of Vanuatu and Tonga as the two of the most likely to be impacted by a future natural disaster. These countries had exposure values of 86.46 and 55.92, respectively, compared to the United States' value of 12.15—lower being less exposed (Bundnis Entwicklung Hilft, 2018). Figure 1 displays the different elements that make up the exposure level and the weight of each factor. This study will evaluate the BEH WorldRiskIndex exposure level for counties requiring humanitarian assistance. The BEH WorldRiskReport is

available from 2011 to 2021, which did not cover the full 40-year period of the study. Since reports for every year were not available, the 2018 Index was used for this study to evaluate all countries dating back as far as 1976. The null and alternate hypotheses for the exposure are:

$$H_{01}: \text{Exposure } \mu \leq 23.92$$

$$H_{a1}: \text{Exposure } \mu > 23.92$$

The exposure level of 23.92 was selected because it is the average of the high and very high quintile country scores. This study will test if the countries needing military assistance exceeds this value. A one-tailed Z-test will be performed on the combined results of the study as well as individually for cyclones, floods, and earthquakes. If the p -value is less than 0.1, this will point to a correlation between exposure level and military humanitarian response. The effect size will also be calculated to identify the magnitude of difference between countries requiring military assistance and the exposure value of less resilient countries in the high and very high quintile.

2.3 Susceptibility

While exposure risk is critical when calculating the probability of a future disaster impacting a country, this information does not specifically provide information to determine if a nation will be decimated by a natural disaster and require assistance from the United States. The BEH WorldRiskIndex susceptibility metric evaluates this situation for each country. Susceptibility is the nation's likelihood of suffering harm following a disaster. Central African Republic had the lowest susceptibility measured on the BEH WorldRiskIndex. With a score of 70, the nation is unable to withstand even the smallest natural disaster (Bundnis Entwicklung Hilft, 2018). Poor infrastructure, excessive poverty, and malnutrition are elements that make a community more susceptible to needing outside assistance if a natural disaster impacted the region. For comparison, the United States has a score of 16.18 which indicates a much stronger infrastructure and national health. Figure 1 displays the different elements that make up the susceptibility level and the weight of each factor. This study will evaluate the BEH WorldRiskIndex susceptibility level for counties requiring humanitarian assistance. Again, the 2018 Index was used to evaluate all countries dating back as far as 1976.

The null and alternate hypotheses for the susceptibility are:

$$H_{02}: \text{Susceptibility } \mu \leq 46.30$$

$$H_{a2}: \text{Susceptibility } \mu > 46.30$$

The susceptibility level of 46.30 was selected because it is the average of the high and very high quintile country scores. The study will test if the countries needing military assistance exceeds this value. A one-tailed Z-test will be performed on the combined results of the study as well as individually for cyclones, floods, and earthquakes. If the p -value is less than 0.1, this will be point to a correlation between susceptibility and military humanitarian response. The effect size will also be calculated to identify the magnitude of difference between countries requiring military assistance and the susceptibility value of less resilient countries.

2.4 Structural Vulnerability

While susceptibility calculates the nation's likelihood of suffering harm, structural vulnerability specifically evaluates a nation's infrastructure. The BEH WorldRiskIndex sustainability factor identifies housing conditions as a major component of determining the susceptibility of the community to natural disaster risk but does not provide any specific data on this element. The FM Global Resilience Index is a much more detailed study for researching the infrastructure component. The Resilience Index examines 12 drivers that range from inherent cyber risk to the rate of urbanization; natural hazard risk quality is the most closely correlated with housing condition. Natural hazard risk quality is defined as the quality and enforcement of a country's building codes with respect to natural hazard-resistant design (80%), combined with the level of risk to the facility, based on the location's RiskMark score (20%) (FM Global, 2021b). The RiskMark score includes fire hazards, natural hazards, human elements and other factors along with the inherent occupancy hazards (FM Global, 2021b). This natural hazard risk quality metric gives a detailed analysis of a general structural vulnerability of a country which is turned into a quantitative score from 0 to 100. Iceland and Croatia had the highest ranking in 2021 with 100 points, and the Vietnam was the lowest with a score of 0 (FM Global, 2021a). The United States received a score of 88, which ranks the country 22nd (FM Global, 2021a). Similar to BEH WorldRiskIndex, the FM Global Resilience Index was not available for the whole period of the study. For continuity, the 2018 FM Global Resilience Index was used to evaluate all countries dating back as far as 1976.

The null and alternate hypotheses for the structural vulnerability are:

$$H_{03}: \text{Structural Vulnerability } \mu \geq 11.85$$

H₃: Structural Vulnerability $\mu < 11.85$

The structural vulnerability level of 11.85 was selected because it is the average of the high and very high quintile country scores. The study will test if the countries needing military assistance exceeds this value. A one-tailed Z-test will be performed on the combined results of the study as well as individually for cyclones, floods, and earthquakes. If the *p*-value is less than 0.1, this will be point to a correlation between structural vulnerability and military humanitarian response. The effect size will also be calculated to identify the magnitude of difference between countries requiring military assistance and the structural vulnerability of less resilient countries.

2.5 Coping Capacity

While susceptibility and structural vulnerability give information on a nation's pre-event exposure to disaster, their coping capacity measures the nation's ability to positively react after a catastrophe occurs. A country with a high coping capability will have sound internal processes, appropriate regionally-based equipment, and trained personnel to assist in the recovery effort. The BEH study uses the term "lack of coping capacity" to keep the quantile classification of 1 (very low) to 5 (very high) consistent in the study. The terms coping capacity and lack of coping capacity will be used interchangeably throughout this paper and will refer to a nation's ability to response to a catastrophe. Austria, with a BEH WorldRiskIndex score of 35.16, had the best coping capability in 2018. The United States ranked 24th with a score of 51.88 (Bundnis Entwicklung Hilft, 2018). Austria has a strong government, robust medical staff and facilities, and systematic insurance process that allows for rapid repair to damaged structures. These elements enable the country to quickly and effectively respond to any disaster that would impact their country. Figure 1 explains the different elements that make up the coping capacity and the weight of each factor. The study will evaluate the BEH WorldRiskIndex coping capacity for counties requiring humanitarian assistance. The 2018 Index was used to evaluate all countries dating back to 1976.

The null and alternate hypotheses for the coping capacity are:

$$H_{04}: \text{Coping Capacity } \mu \leq 83.86$$

$$H_{a4}: \text{Coping Capacity } \mu > 83.86$$

The coping capacity of 83.96 was selected because it is the average of the high and very high quintile country scores. The study will test if the countries needing military assistance exceeds this score. A one-tailed Z-test will be performed on the combined results of the study as well as individually for cyclones, floods and earthquakes. If the *p*-value is less than 0.1, this will be point to a correlation between a coping capacity and military humanitarian response. The effect size will also be calculated to identify the magnitude of difference between countries requiring military assistance and coping capacity of less resilient countries.

3. Results

3.1 Military Response Events

The results of the Humanitarian Service Medal classification are presented in Table 2. There were 282 major humanitarian events that the United States military assisted with between 1975 and 2018. Of these events, 199 required some level of foreign assistance. For an event to be included in the study, the exact country impacted needed to be identified and the country required BEH WorldRiskIndex or FM Global Resilience data available. A total of 54 events are included in this study.

Table 2. Humanitarian Service Medal's issued by event classification

Category	Total Events	Excluding US Events	Events in Study
Cyclone	49	36	22
Flood	42	15	11
Earthquake	26	22	21
Tornado	14	0	-
Fire	8	2	-
Volcano	5	4	-
Winter Storm	5	0	-

Famine	1	1	-
Drought	1	1	-
Tsunami	1	1	-
Other	130	117	-
Total	282	199	54

3.2 Exposure

Exposure gives a predictive view on the likelihood that a nation will be impacted by a future disaster. Almost 80% of countries requiring military humanitarian response had exposure values in the high or very high exposure quintile range. There was only one country requiring assistance that fell into the bottom 20% exposure score. Table 3 displays results of the analysis based on exposure quintile score. The humanitarian events were then evaluated based on the category of the event. There were 54 cyclones, floods, and earthquakes that required military response during the period of the study. The mean exposure score for all events was 26.3. Cyclones had the most events and highest exposure score of 32.6. Table 4 displays the mean exposure score, standard deviation, and effect size for cyclones, floods, and earthquakes. Figure 2 graphically displays the disasters based on date and exposure level. Additionally, cyclones, floods and earthquakes are color coded so the different types of events can be identified. When calculating the z-test and effect size, the statistical population of countries in the high and very high quintile range had a mean of 23.9 and standard deviation of 12.8.

Table 3. BEH WorldRiskIndex Exposure Quintile Scores for Military Humanitarian Response

Classification	Exposure Score Range	Number of events	Percentage
Very Low	1.02 – 9.53	1	1.9%
Low	9.54 – 11.70	2	3.7%
Medium	11.71 – 14.50	8	14.8%
High	14.51 – 17.73	17	31.5%
Very High	17.74 – 86.46	26	48.1%

Table 4. BEH WorldRiskIndex Exposure Scores for Military Humanitarian Response

Category	Number of events	Mean	S.D.	Effect Size
Cyclone	22	32.6***	18.7	0.68
Flood	11	20.0	11.6	-0.31
Earthquake	21	23.0	12.7	-0.07
Total	54	26.3*	15.9	0.19

* $p = 0.10$, ** $p = 0.05$, *** $p = 0.01$

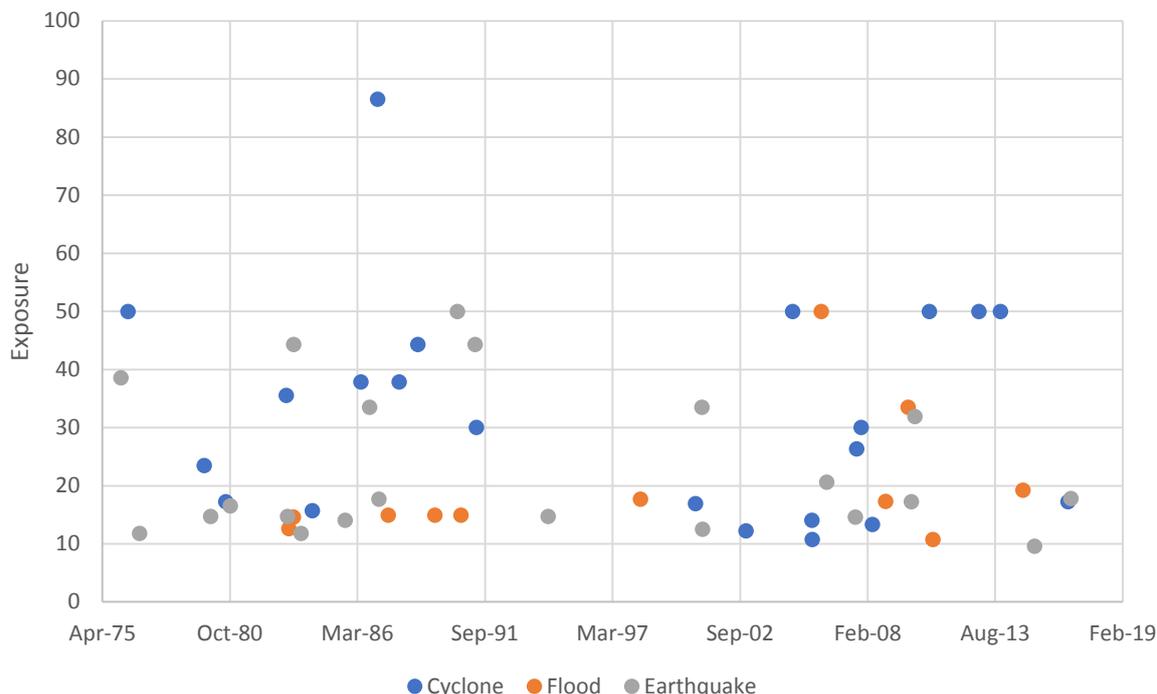


Figure 2. BEH WorldRiskIndex exposure values for United States international response efforts

3.3 Susceptibility

Susceptibility is the nation’s likelihood of suffering harm following a disaster. Almost 45% of countries requiring military humanitarian response had susceptibility values in the high or very high exposure quintile range. There were five country requiring assistance that were included in the bottom 20% susceptibility score. Table 5 displays results of the analysis based on susceptibility quintile score. The humanitarian events are further broken down and evaluated based on the category of the event. The mean sustainability score for all events was 28.8. Cyclones had the most events and highest susceptibility score of 34.0. Table 6 displays the mean exposure score, standard deviation and effect size for cyclones, floods, and earthquakes. Figure 3 graphically displays the disasters based on time and sustainability level. Additionally, cyclones, floods and earthquakes are color coded so the different types of events can be identified. When calculating the z-test and effect size, the statistical population of countries in the high and very high quintile range had a mean of 46.3 and standard deviation of 11.4.

Table 5. BEH WorldRiskIndex Susceptibility Quintile Scores for Military Humanitarian Response

Classification	Susceptibility Score Range	Number of events	Percentage
Very Low	8.26 – 17.05	5	9.3%
Low	17.06 – 20.81	6	11.1%
Medium	20.82 – 28.80	19	35.2%
High	28.81 – 46.48	18	33.3%
Very High	46.49 – 70.00	6	11.1%

Table 6. BEH WorldRiskIndex Susceptibility Scores for Military Humanitarian Response

Category	Number of events	Mean	S.D.	Effect Size
Cyclone	22	34.0	12.3	-1.07
Flood	11	23.8	7.3	-1.97
Earthquake	21	26.3	8.0	-1.75
Total	54	28.8	10.5	-1.53

* $p = 0.10$, ** $p = 0.05$, *** $p = 0.01$

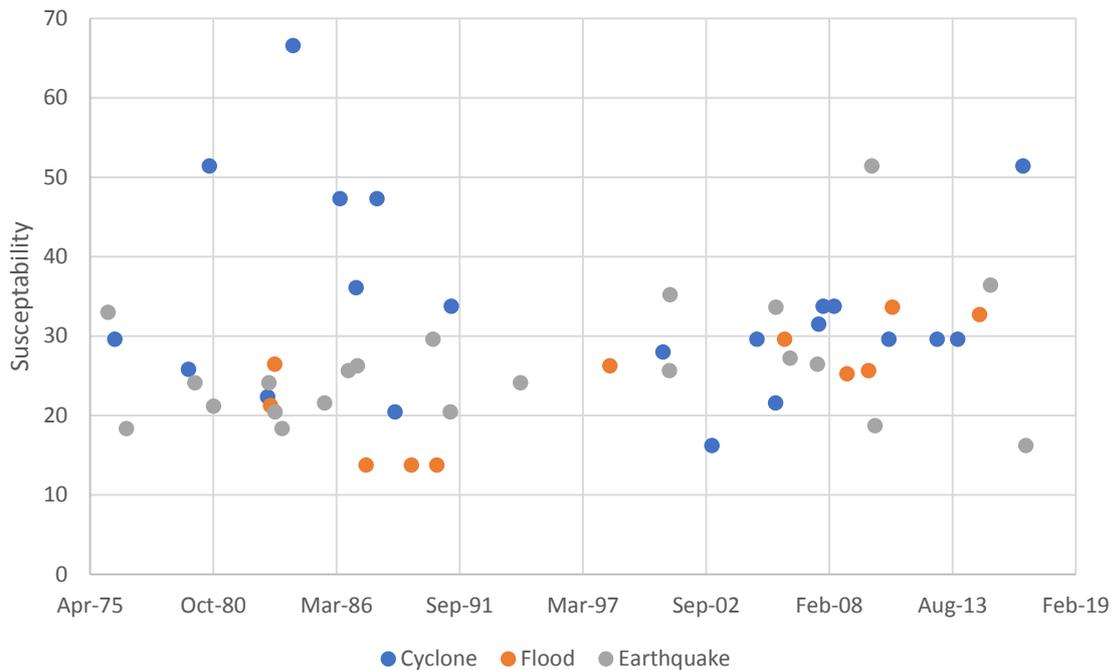


Figure 3. BEH WorldRiskIndex sustainability values for United States humanitarian response to earthquakes, cyclones, and floods

3.4 Structural Vulnerability

Structural vulnerability is defined as the quality and enforcement of a country’s building codes with respect to natural hazard-resistant design. This value is based on the FM Global Natural Hazard Risk Quality score. Over 65% of countries requiring military humanitarian response had a structural vulnerability value in the high or very high exposure quintile range. There were no countries that fell into the bottom 20% structural vulnerability score. Table 7 displays results of the analysis based on structural vulnerability quintile score. The humanitarian events are further broken down and evaluated based on the category of the event. The mean structural vulnerability score for all events was 20.3. Earthquakes had the most events and highest structural vulnerability score of 24.2. Table 8 displays the mean structural vulnerability score, standard deviation, and effect size for cyclones, floods, and earthquakes. Figure 4 graphically displays the disasters based on date and sustainability level. Additionally, cyclones, floods and earthquakes are color coded so the different types of events can be identified. When calculating the z-test and effect size, the statistical population of countries in the high and very high quintile range had a mean of 11.9 and standard deviation of 9.2.

Table 7. FM Global Natural Hazard Risk Quality Quintile Scores for Military Humanitarian Response

Classification	Natural Hazard Risk Range	Number of events	Percentage
Very Low	100.0 – 77.6	5	9.3%
Low	77.5 – 35.8	6	11.1%
Medium	35.7 – 23.3	19	35.2%
High	23.2 – 10.8	18	33.3%
Very High	10.7 – 0.0	6	11.1%

Note: Higher scores equate to a lower structural vulnerability.

Table 8. FM Natural Hazard Risk Quality Scores for Military Humanitarian Response

Category	Number of events	Mean	S.D.	Effect Size
Cyclone	14	17.4	14.0	-0.60
Flood	11	16.2	11.4	-0.47
Earthquake	22	24.2	17.7	-1.34
Total	47	20.3	15.5	-0.92

* $p = 0.10$, ** $p = 0.05$, *** $p = 0.01$

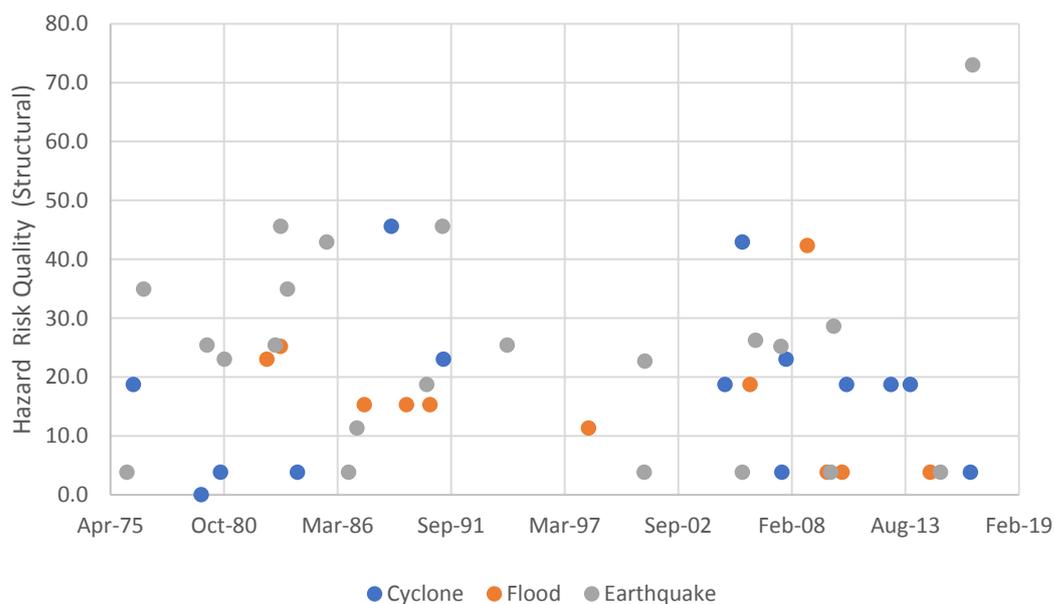


Figure 4. FM Natural Hazard Risk Quality Score values for United States humanitarian response to earthquakes, cyclones, and floods

3.5 Coping Capacity

Coping capacity is measured by a nation’s ability to positively react after a catastrophe occurs. Over 48% of countries requiring military humanitarian response had a lack of coping capacity value in the high or very high exposure quintile range. There were five country requiring assistance that were included in the bottom 20% coping capacity score. Table 9 displays results of the analysis based on coping capacity quintile score. The humanitarian events are future broken down and evaluated based on the category of the event. The mean coping capacity score for all events was 74.4. Earthquakes had the second most events and highest lack of coping

capacity score of 79.1. Table 10 displays the mean coping capacity score, standard deviation and effect size for cyclones, floods, and earthquakes. Figure 5 graphically displays the disasters based on date and lack of coping capacity level. Additionally, cyclones, floods and earthquakes are color coded so the different types of events can be identified. When calculating the z-test and effect size, the statistical population of countries in the high and very high quintile range had a mean of 83.8 and standard deviation of 4.0.

Table 9. BEH WorldRiskIndex Lack of Coping Capacity Quintile Scores for Military Humanitarian Response

Classification	Lack of Coping Capacity Range	Number of events	Percentage
Very Low	35.16 – 53.90	5	9.3%
Low	53.91 – 67.73	5	9.3%
Medium	67.74 – 76.73	18	33.3%
High	76.74 – 84.10	16	29.6%
Very High	84.10 – 92.28	10	18.5%

Note: Higher scores equate to a lower coping capacity.

Table 10. BEH WorldRiskIndex Lack of Coping Capacity Scores for Military Humanitarian Response

Category	Number of events	Mean	S.D.	Effect Size
Cyclone	22	73.3	10.1	-2.66
Flood	11	67.5	15.3	-4.13
Earthquake	21	79.1	9.8	-1.21
Total	54	74.4	11.8	-2.40

* $p = 0.10$, ** $p = 0.05$, *** $p = 0.01$

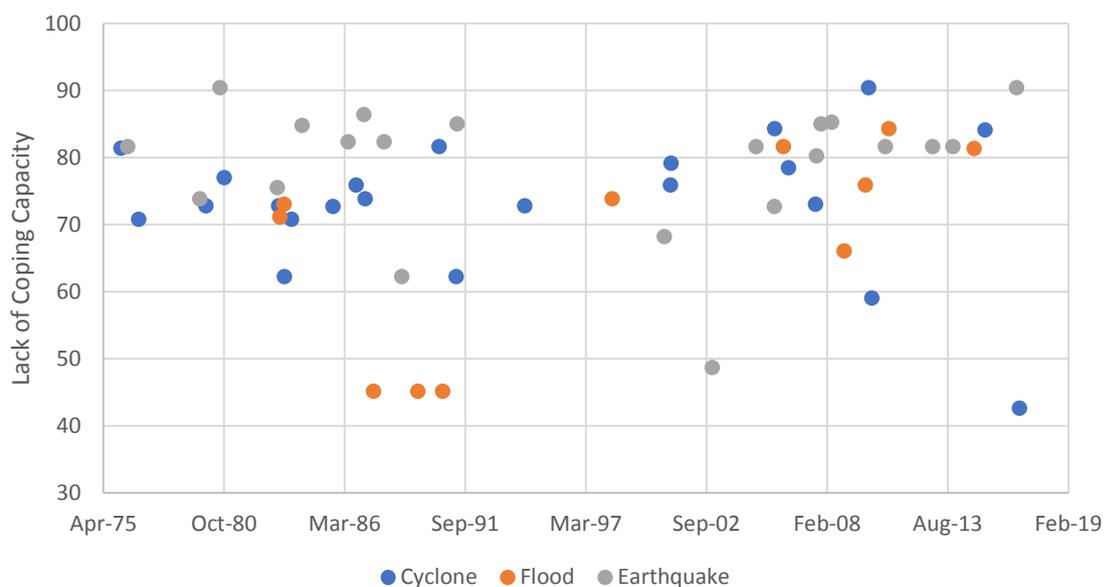


Figure 5. BEH WorldRiskIndex lack of coping capacity values for United States humanitarian response to earthquakes, cyclones, and floods

4. Discussion

4.1 Exposure

The null and alternate hypotheses for the exposure are:

H_{01} : Exposure $\mu \leq 23.92$

H_{a1} : Exposure $\mu > 23.92$

The mean exposure level for countries requiring military humanitarian assistance was 26.3. The null hypothesis is rejected and the alternate hypothesis is accepted (p value = 0.08). The mean country exposure level for countries requiring military humanitarian response is greater than the mean of countries in the high and very high quintile.

Over 48% of the countries needing assistance fall in the very high quartile and almost 80% were in either the very high or high quartile. There appears to be a strong correlation between a country’s exposure score and the need for military humanitarian assistance. The effect size of 0.16 indicates the humanitarian response mean is just slightly over the high/very high quartile mean. The exposure score is heavily weighted by a population’s opportunity to be impacted by future cyclones, floods or earthquakes. Since over 75% of identified military humanitarian events are in response to these types of disasters, it is logical that there is a correlation between the two scores.

The results of this analysis can assist military commanders with humanitarian response planning. The commanders can examine the exposure values of countries in their area of responsibility and create specific response plans for all countries with an exposure value greater than 26.3 (the mean value for military humanitarian responses).

4.2 Susceptibility

The null and alternate hypotheses for the susceptibility are:

H_{02} : Susceptibility $\mu \leq 46.30$

H_{a2} : Susceptibility $\mu > 46.30$

The mean susceptibility level for countries requiring military humanitarian assistance was 28.8. The null hypothesis is accepted and the alternate hypothesis is rejected. The mean susceptibility level for countries requiring military humanitarian response is less than mean of countries in the high and very high quintile.

It was assumed that vulnerable nations with limited infrastructure, poor nutrition, and excessive poverty would need more military humanitarian assistance following a natural disaster. While this may be true, most of the nations that have a very high susceptibility score do not have a very high exposure score—meaning there is less opportunity for the disaster to occur. Table 11 displays the comparison between exposure and susceptibility quartiles. Most of the countries in the very high susceptibility classification are from Africa; this region contained 24 of the 25 countries most likely to suffer harm following an event mainly due to poor nutrition and high levels of poverty. The United States has completed 30 humanitarian responses to Africa over the period of the study with 83% of the response classified as ‘other’ (i.e., preventative medicine, evacuations, and refugee support). This research focused on cyclone, earthquake and flood disaster response and ‘other’ humanitarian events are not included in this study. The susceptibility level of a country does not have a significant impact on the military response for humanitarian events caused by natural disasters. Future research should be conducted to determine if there are elements of susceptibility that would drive future military humanitarian response efforts.

Table 11. Comparison between Exposure and Susceptibility quartiles

		Exposure				
		Very High	High	Medium	Low	Very Low
Susceptibility	Very High	4	10	12	7	2
	High	12	5	6	5	6
	Medium	7	11	7	3	6
	Low	8	5	5	9	8
	Very Low	4	3	4	11	12

4.3 Structural Vulnerability

The null and alternate hypotheses for structural vulnerability are:

$$H_{03}: \text{Structural Vulnerability } \mu \geq 11.85$$

$$H_{a3}: \text{Structural Vulnerability } \mu < 11.85$$

The mean structural vulnerability level for countries requiring military humanitarian assistance was 20.3. The null hypothesis is accepted, and the alternate hypothesis is rejected. The mean structural vulnerability level for countries requiring military humanitarian response is greater than mean of countries in the high and very high quintile.

It was hypothesized that as the quality and enforcement of a country's building codes with respect to natural hazard-resistant design decreased, the likelihood that the country would need military assistance following a natural disaster would increase. There does not appear to be a strong correlation between these variables. It is possible that the strength of the natural disasters exceeds the building codes for the country's effected. The mean magnitude earthquake that the United States military responded to over the 40 years of the study was 7.3 M_L (Long, 2020). This level of earthquake would likely not result in building collapse or loss of life in the United States where the country adopts the building codes called "International Codes" (ICC, 2018). Additional research is required to determine if the military response was because the strength of the natural disaster exceeded the building codes for that nation.

4.4 Coping

The null and alternate hypotheses for the lack of coping capacity are:

$$H_{04}: \text{Lack of Coping Capacity } \mu \leq 83.86$$

$$H_{a4}: \text{Lack of Coping Capacity } \mu > 83.86$$

The mean lack of copying capacity level for countries requiring military humanitarian assistance was 74.4. The null hypothesis is accepted, and the alternate hypothesis is rejected. The mean lack of copying capacity level for countries requiring military humanitarian response is less than mean of countries in the high and very high quintile.

It was assumed that there would be a connection between a nation's inability to positively react after a disaster occurs and military humanitarian response. There does not appear to be a correlation between these variables. Like the discussion on structural vulnerability, it is possible that the natural disasters requiring military humanitarian assistance exceeds the effected nation's ability to plan for the event. The United States has robust response capability and scores in the very low quintile on the lack of coping capacity metric. In the wake of Hurricane Katrina, the United States was overwhelmed with the recovery efforts which forced hundreds of thousands of individuals to evacuate New Orleans. To assist the United States with their recovery efforts, more than 151 foreign countries and international organizations pledged to assist with post disaster efforts or provide aid donations (Mayer et. al., 2011). The magnitude of this storm at landfall was 125 miles per hour which was equal to mean cyclone strength that the United States military responded to over the 40 years of this study (Reid, 2019, Long, 2020). It is possible that major disasters that require military humanitarian assistance would exceed any countries coping capacity. Additional research should be conducted to determine why the coping capacity of a country is exceeded.

4.5 Finding Importance

Humanitarian response efforts are difficult to predict because many variables impact the final decision to deploy forces. The results of this study will provide critical information to the United States military commanders who plan for and respond to humanitarian disasters. Understanding the exposure, susceptibility, structural vulnerability and coping capacity of countries that required military assistance will allow the planners to focus their efforts on countries that show the highest level of risk. The mean values for cyclone, floods and earthquake can be used as indicators that a country impacted by a disaster will need military humanitarian assistance.

5. Conclusion

This study examined the military response to natural disasters with a focus on the resilience of affected nations. The study did not confirm that less resilient nations are more likely to need external assistance. Only a country's exposure to natural disasters showed a strong correlation to a need for military humanitarian assistance. The research shows foreign countries will likely request the United States military aid if they have an exposure value greater than 26.3.

The least resilient countries, as measured by susceptibility, structural vulnerability, copying capacity, did not show a statistically significant need for military response. There are likely two reasons for this result. First, many of the least resilient countries are in regions that not regularly impacted by cyclones, floods, or earthquakes. For example, Africa contains many vulnerable countries, but the continent only had three of the 52 events that required military assistance. The lack of opportunity should not be equated to a lack of need. Second, many of the disaster are so powerful that even resilient countries require military humanitarian assistance to support the local population. Foreign countries will likely request the military assistance for cyclones with speeds greater than 125 miles an hour and earthquakes with a magnitude of 7.4 or higher (Long, 2020). These powerful disasters could negatively impact even the most hardened and prepared countries.

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