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Identifying the Strength of Cyclones and Earthquakes Requiring Military Disaster Response

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***Abstract*—**The United States military is now commonly responding to complex humanitarian emergencies and natural disasters around the world. From catastrophic earthquakes in Haiti to typhoons devastating the Philippines, U.S. military assistance is requested when the event exceeds the local government's ability to assist the population. This study assesses the characteristics of catastrophes that surpass a nation's individual ability to respond and recover from the event. The paper begins with a historical summary of military aid and then analyzes over 40 years of the United States military humanitarian response. Over 300 military operations were reviewed and coded based on the nature of the disaster. This in-depth study reviewed the U.S. military's deployment events for cyclones and earthquakes to determine the strength of the natural disaster requiring external assistance. The climatological data for cyclone landfall and magnitude data for earthquake epicenters were identified, grouped into regions and analyzed for time-based trends. The results showed that foreign countries will likely request the U.S. military for cyclones with speeds greater or equal to 125 miles an hour and earthquakes at the magnitude of 7.4 or higher. These results of this study will assist the geographic combatant commands in determining future military response requirements.

***Keywords*—**Cyclones, earthquakes, natural disasters, military.

I. Introduction

THE United States military is regularly called to assist nations impacted by natural disasters. These calamitous events can be caused by floods, tornados, volcanos, earthquakes or numerous other catastrophes that strain the local government's response efforts and require external assistance to save lives or reduce suffering for their citizens. This study examined the strength of catastrophes that surpass a nation's capability to either directly assist their population during the disaster or implement recovery efforts to rebuild the nation's infrastructure. The paper starts with an in-depth examination of military aid and then focuses on the United States' Department of Defense (DoD) assistance. The records, spanning over 40 years of United States military aid, are reviewed, categorized, and examined in this study. All deployment events for cyclones and earthquakes are researched and analyzed to determine the strength of the natural disaster requiring military assistance. The results of this study will assist the geographic combatant commands in categorizing disaster events and predicting future military response needs.

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II. History of Military Humanitarian Response

Humanitarian aid has been around since the beginning of time. Many centuries ago, the help primarily took the form of material assistance—providing food during a drought or support rebuilding of shelters after a natural disaster [1]. These early events focused on assisting extended family or tribal members in trouble and aid was not commonly offered to strangers. With the rise of organized religions, the idea of helping another in need became very important to many societies. The Christian concept of charity and the tradition of zakat in Islam pressed believers to relieve the suffering of the disadvantaged both inside and outside of their local community [2]. Humanitarianism continued to grow with the Treaty of Versailles, signed after World War I. The peace treaty created the League of Nations, an international body that had the mission of protecting vulnerable populations around the world [1]. This organization transformed into the United Nations after World War II and expanded its philanthropic assistance through programs such as the United Nations International Children's Emergency Fund (UNICEF), the World Health Organization (WHO), and the United Nations Refugee Agency (UNHCR) [1].

The United States military had a role in humanitarian response within the national environment well before the founding of the United Nations. In 1906, San Francisco was struck by a massive earthquake which leveled most of the city and left hundreds of thousands homeless [3]. The local government was unable to respond to the colossal event and enlisted the assistance of the United States Army. The Army immediately supported the humanitarian effort by controlling the fire damage. The military units also helped with supplying shelter and clothing to many of the homeless as well as providing security against looters [3]. In these early years, the military offered assistance to any American state that required their trained personnel or specialized equipment to help a community in distress, but they were not able to assist a foreign government. In 1961, the United States passed the Foreign Assistance Act which amended the restrictions on title 10 of the U.S. Code [4]. The United States military was authorized to preserve life, alleviate suffering, and complete rehabilitation projects in foreign nations affected by human-made or natural disaster [4]. The distressed foreign government just needed to request aid to receive American humanitarian assistance. The military has responded to numerous international events this decade; they moved 5 million tons of supplies in Pakistan after massive flooding and assisted with the stability of the Fukushima nuclear reactor damaged by immense earthquakes in Japan [5].

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The response to these natural disasters is a critical part of the United States plan to spread influence using soft-power diplomacy [6]. This instrument helps ensure the safety and security of the world's nations along with increasing ties with the United States [7]. In some of the poorer or destabilized countries, humanitarian assistance reduces the chance that fundamentalist groups or rebel movements can take advantage of the population [7]. The small investment in these philanthropic events pales in comparison to funding conflicts to remove authorization dictatorships once they have control of a country. In 2019, the President's Budget has less than 0.5% of the government's spending, about $16.8 billion, set aside for foreign aid [8]. The DoD also has a line item in its budget for humanitarian assistance. This philanthropic aid has been a significant mission for the armed forces since the 1992 National Military Strategy was published, and now the government specifically budgets for humanitarian events [9]. The military can expect to spend around $118 million on assistance projects in 2019 [10]. The DoD humanitarian assistance spending has been on the rise over the last 15 years. In 2004, the DoD completed 638 humanitarian projects at the cost of $47.2 million [11]. By 2010, the DoD budget for humanitarian events had climbed to $109 million [11]. The DoD can expect that the humanitarian mission will continue to grow into the future as the number of disasters is on the rise; since 1970 the number of catastrophes has quadrupled [12].

III. Military Response Events

The world can expect around 13,000 earthquakes and 80 tropical cyclones each year [13]. Clearly, the United States military would not be required or able to respond to all of these events. The amount of destruction and risk of human suffering created by each occurrence drives the military's humanitarian assistance response. The United States government has not established a table that describes the deployment criteria for disaster response; each event is individually examined based on the climatological, geographic, demographic and political factors. To get a better understanding of the climatological factors, a complete review of the Humanitarian Service Medal historical records was needed. These records document the military's involvement in large humanitarian aid events.

The Humanitarian Service Medal was created by President Gerald Ford which granted the award to individuals, as part of a coordinated DoD response, taking part in a significant humanitarian act after April 1, 1975 [14]. The medal displays the international symbol of aid, an outstretched hand with the palm up. Over 300 military operations have been approved to receive the medal. The activities include a diverse range of support including regional conflicts, aircraft disasters, mass refugee migrations, famine relief, animal disease eradication along with a variety of natural disasters aid. This study examined the Humanitarian Service Medal records from 1975 up to and including 2018 [15]. The researcher coded each incident by the type of event and the location's geographic combatant command. If the government awarded multiple medals for the same episode, the response efforts were combined into a single occurrence. The different disaster events include earthquakes, tropical cyclones, tsunamis, floods, droughts, winter storms, tornados, volcano eruptions, fires, famine and other. The "other" category included all non-natural events, as well as unknown events that had a description that was too vague to be coded. The results of the Humanitarian Service Medal classification are presented in Table I.

TABLE I
HUMANITARIAN SERVICE MEDALS BY EVENT

Category	Quantity
Cyclone	49
Flood	42
Earthquake	26
Tornado	14
Fire	8
Volcano	5
Winter Storm	5
Famine	1
Drought	1
Tsunami	1
Other	130
Total	**282**

The United States military responds to a large variety of disasters unevenly dispersed throughout the world. For example, 68% of the floods and 71% of the fire responses occurred in the United States under USNORTHCOM control. The results of the Humanitarian Service Medal classification by the geographic combatant commander are presented in Table II.

TABLE II
HUMANITARIAN SERVICE MEDALS LOCATION BY GEOGRAPHIC COMBATANT COMMANDER

Commander	Quantity
USNORTHCOM	90
USINDOPACOM	68
USSOUTHCOM	54
USAFRICOM	30
USCENTCOM	20
USEUCOM	18
Unknown	2
Total	**282**

Once the researcher classified military responses by the humanitarian event, the climatological factors of the natural disasters were evaluated. The first natural disaster examined was tropical cyclones.

A. Cyclones

During the 43-year period in this study, 1346 storms reached the 74 miles per hour wind speed requirement to be classified as a cyclone [16]. Out of approximately one thousand weather events, the United States military responded to 49 cyclone disasters in four different geographic combatant commander's area of responsibility: USNORTHCOM (17), USSOUTHCOM (10), USAFRICOM (1), and

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USINDOPACOM (21). Each of the 49 cyclones was evaluated, by exploring Weather Underground's Hurricane and Tropical Cyclone database, to determine the wind speed when the storm made landfall. If the hurricane data were not available on the Weather Underground website, the event was researched in newspapers, books or other online resources to determine climatological data. The cyclone humanitarian event considers both the destructive effects of the wind and related storm surge. If the landfall wind speed still could not be determined, then the 10-minute maximum sustained rate for the storm was used. Any storm that had a landfall or max sustained wind speed of less than 74 miles per hour was reclassified as a flood event.

The results of this analysis showed that the average wind speed for a cyclone that received United States military humanitarian relief was 123.0 miles per hour. At this speed, the storm is classified as a category three hurricane on the Saffir-Simpson hurricane wind scale [17]. The geographic combatant commands were analyzed to determine if there was a significant difference between the storm levels in different regions. The results are presented in Table III.

TABLE III
GEOGRAPHIC COMBATANT COMMANDER HUMANITARIAN RESPONSE BASED ON CYCLONE WIND SPEED (WS)

Commander	Quantity	Avg WS (mph)	St. Dev. WS (mph)
USINDOPACOM	21	117.7	26.6
USNORTHCOM	17	120.6	17.4
USSOUTHCOM	10	140.0	27.5
USAFRICOM	1	103.0	n/a
Total	**49**	**123.0**	**24.9**

The most notable difference in wind speed was USSOUTHCOM; its area of responsibility contains the Bahamas and Caribbean Islands which commonly experience cyclone activity. The average wind speed for a response in this combatant command was slightly higher than the average at 140.0 miles per hour, a category four hurricane on the Saffir-Simpson hurricane wind scale [17].

A time-based analysis was completed on cyclones to determine if there was a trend to the response effort. This analysis was critical in determining any change in strength over the 40-year study. Fig. 1 presents the results; the scatter chart shows a slight upward trend during the study's period. It appears the intensity of storms has increased over the last decade—three events were over 160 mph compared to two storms during the previous 30 years. This trend is discussed in detail later in the paper. Also of note is the decrease in responses to less powerful cyclones, under 100 mph, over the last decade. It is likely that improved weather forecasting and coastal construction enhancements have decreased the requirement for U.S. military assistance. Based on these trends, it is likely that future cyclones will need to be stronger than the historical 123 mph average to receive a military response. Due to the slight positive increase in the trend, a 125-mph cyclone speed should be used for predicting future responses.

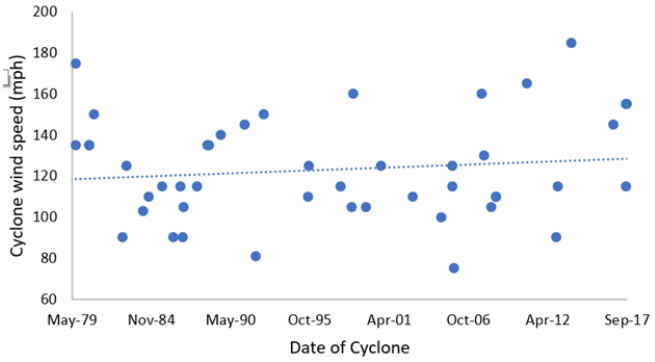


Fig. 1 Scatter chart of cyclone wind speed for military humanitarian response efforts

B. Earthquake

Almost 500,000 earthquakes occurred on the planet during the 43-year period of this study [13]. Out of the half-million events, the United States military responded to 26 earthquake disasters in every geographic combatant commander's area of responsibility: USSOUTHCOM (12), USNORTHCOM (4), USINDOPACOM (5), USEUCOM (3), USAFRICOM (1), and USCENTCOM (1). These results just look at the impact of the earthquake and not secondary effects such as tsunamis, which are classified as separate disasters. Each of the 24 earthquakes was evaluated by exploring newspapers, books or other online resources to determine the Richter Scale magnitude of the event.

The results of this analysis showed that the average magnitude for an earthquake that received United States military humanitarian relief was 7.3 M_L. On the Richter Scale, this would be a major earthquake characterized by buildings displaced, fissures in the earth, and underground pipes cracked [18]. The geographic combatant commands were analyzed to determine if there was a significant difference between the earthquake levels in unique regions. The results are presented in Table IV and show the average earthquake magnitude was similar between geographic areas.

TABLE IV
GEOGRAPHIC COMBATANT COMMANDER HUMANITARIAN RESPONSE BASED ON EARTHQUAKE RICHTER SCALE SCORE (M_L)

Commander	Quantity	Avg (M_L)	St. Dev. (M_L)
USSOUTHCOM	12	7.4	0.8
USINDOPACOM	5	7.5	0.7
USNORTHCOM	4	7.1	0.7
USEUCOM	3	7.1	0.2
USAFRICOM	1	7.2	n/a
USCENTCOM	1	7.6	n/a
Total	**49**	**7.3**	**0.7**

A time-based analysis was completed on earthquakes to determine if there was a trend to the response effort. Fig. 2 presents the results; the scatter chart shows an increase in the magnitude over the 40-year period. This trend indicates that current responses are for higher magnitude earthquakes compared to historical response efforts. This change makes logical sense as earthquake-proof construction has improved

over the last 40 years reducing the damage in more modern cities.

Based on the positive trend, it is likely that future earthquakes will need to be stronger than the historical 7.3 M_L average to receive a military response. The Richter scale increments represent an increase of ten times the power of the earthquake [18]. For example, a level 6 M_L earthquake is ten times stronger than a level 5 M_L earthquake. With 10x increase considered with the positive trend in historical response efforts, a Richter score of 7.4 should be used as a future response level.

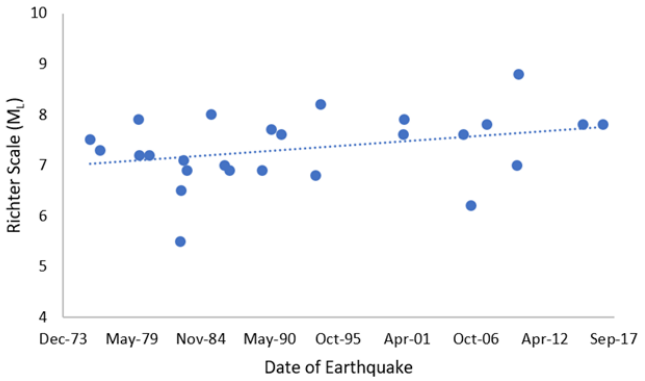


Fig. 2 Scatter chart of Earthquake Richter Scale scores for military humanitarian response efforts.

IV. Future Research

The research in this paper gives a clear picture of the power of a cyclone or earthquake event that required a military response. If all countries in the world were equal, then this study's information would be enough to forecast future response efforts. Unfortunately, they are not, which means that a nation's resiliency must be considered.

The ability of a government to internally respond and recover from a significant disaster must take into account a couple of different elements. The most important is the resiliency of a nation's infrastructure. The buildings and structures in the community must be built to withstand major cyclones and earthquakes. A very close second is their response capability; the nation's ability to assist their citizens after the disaster. They need to have dynamic internal response processes in place that can supply aid to their population without external assistance. A country with robust infrastructure and excellent response processes and equipment will be able to handle much larger disasters compared to a more impoverished, less organized nation. For example, the United States was able to internally respond to Hurricane Michael which was classified as a major category 4 hurricane with a wind speed of 155 mph [19]. A less resilient country such as Haiti would surely need United States assistance if a storm of that magnitude impacted their nation. An analysis of the resiliency of each nation concerning 7.4 magnitude earthquakes and cyclones with wind speeds greater or equal to 125 mph should be conducted.

This study could be expanded to take into account population centers. If a 7.4 magnitude earthquake happens in the middle of an unpopulated desert, then it is likely no response will be required. On the other hand, a similar disaster in a major metropolitan area could stress the local resources of all but the most robust nations, forcing them to require external aid. The ability to weigh a nation's resiliency and the probability of future disaster by the number of lives at risk could assist a geographic combatant commander with their humanitarian response planning efforts.

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