NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

MBA PROFESSIONAL REPORT

ANALYSIS OF THE CAPABILITIES SUPPORTING HUMANITARIAN ASSISTANCE AND DISASTER RELIEF OPERATIONS OF THE INDONESIAN NAVY (TNI AL) AND THE UNITED STATES MARINE CORPS MARINE EXPEDITIONARY UNIT (USMC MEU)

December 2015

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REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704–0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** December 2015	**3. REPORT TYPE AND DATES COVERED** MBA professional report

4. TITLE AND SUBTITLE
ANALYSIS OF THE CAPABILITIES SUPPORTING HUMANITARIAN ASSISTANCE AND DISASTER RELIEF OPERATIONS OF THE INDONESIAN NAVY (TNI AL) AND THE UNITED STATES MARINE CORPS MARINE EXPEDITIONARY UNIT (USMC MEU)

5. FUNDING NUMBERS

6. AUTHOR(S) M. Reza Achwandi, Danny A. Hamler and Todd A. Hoyt

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943–5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB Protocol number ____N/A____.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200 words)

The 2014 Quadrennial Defense Review emphasized the importance of the Humanitarian Assistance/Disaster Relief (HA/DR) mission in rebalancing the Asia-Pacific region. The coupling of the U.S. pivot to the Pacific and the frequency of natural disasters in the vicinity of Sumatra, Indonesia, focused this research project on the disaster response capabilities of the Indonesian Navy (Tentara Nasional Indonesia Angkatan Laut [TNI AL]) and the United States Marine Corps–Marine Expeditionary Unit (USMC MEU). To examine the gaps between demand and supply, we derived potential demand through the analysis of historical HA/DR scenarios while garnering potential supply through a study of the TNI AL and USMC MEU organic assets. Through this analysis, we created a capabilities matrix to capture and present both the quantitative and qualitative aspects of HA/DR demand and available responder supply. This matrix encompasses the general categories of personnel, material, logistics, and communication, and how these categories affect the availability of medical support, sustenance, habitat, and infrastructure. The completed matrix identified regional capability shortfalls that can be addressed to increase future HA/DR responsiveness. These include the procurement of additional vertical lift, the pre-positioning of critical supplies, and the building of population resiliency.

14. SUBJECT TERMS
humanitarian assistance, disaster relief, disaster preparedness, capabilities and competencies, collaboration and coordination, military to military partnerships, military capabilities

15. NUMBER OF PAGES 95

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540–01–280–5500

Standard Form 298 (Rev. 2–89)
Prescribed by ANSI Std. 239–18

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Submitted in partial fulfillment of the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

NAVAL POSTGRADUATE SCHOOL
December 2015

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The 2014 Quadrennial Defense Review emphasized the importance of the Humanitarian Assistance/Disaster Relief (HA/DR) mission in rebalancing the Asia-Pacific region. The coupling of the U.S. pivot to the Pacific and the frequency of natural disasters in the vicinity of Sumatra, Indonesia, focused this research project on the disaster response capabilities of the Indonesian Navy (Tentara Nasional Indonesia Angkatan Laut [TNI AL]) and the United States Marine Corps–Marine Expeditionary Unit (USMC MEU). To examine the gaps between demand and supply, we derived potential demand through the analysis of historical HA/DR scenarios while garnering potential supply through a study of the TNI AL and USMC MEU organic assets. Through this analysis, we created a capabilities matrix to capture and present both the quantitative and qualitative aspects of HA/DR demand and available responder supply. This matrix encompasses the general categories of personnel, material, logistics, and communication, and how these categories affect the availability of medical support, sustenance, habitat, and infrastructure. The completed matrix identified regional capability shortfalls that can be addressed to increase future HA/DR responsiveness. These include the procurement of additional vertical lift, the pre-positioning of critical supplies, and the building of population resiliency.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAR	After Action Report
ABC	Asia Broadcasting Corporation
ACE	Air Combat Element
ACT	Assessment and Consequence Team
ADF	Australian Defence Force
AOR	Area of Responsibility
APS	Africa Partnership Station
ARG	Amphibious Readiness Group
ASEAN	Association of South East Asian Nations
ASW	Anti-Submarine Warfare
BBC	British Broadcasting Corporation
BFT	Blue Force Tracker
BGAN	Broad Global Area Network
BLT	Battalion Landing Team
BNPB	Badan Nasional Penanggulangan Bencana (Indonesian National Board of Disaster Management)
CBIRF	Chemical Biological Incident Response Force
CBRN	Chemical, Biological, Radiological, Nuclear
CE	Combat Element
CER	Combat Engineer Regiment
CLB	Combat Logistics Battalion
COC	Command and Control Operation Center
CONUS	Continental United States
CSG	Carrier Strike Group
DMIS	Disaster Management and Information System
DOD	Department of Defense
DSN	Data Source Name

EEZ	Exclusive Economic Zone
EM-DAT	The International Disaster Database
EMF	Expeditionary Medical Facilities
EOD	Explosive Ordinance Disposal
EOP	Emergency Operation Plan
EOS	Earth Observatory of Singapore
ERU	Emergency Response Unit
FAST	Fleet Anti-terrorist Security Team
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GAO	Government Accountability Office
GCE	Ground Combat Element
GoH	Government of Haiti
GoI	Government of Indonesia
GoJ	Government of Japan
GoKoN	Government of Kingdom of Norway
GP	General Purpose
HA/DR	Humanitarian Assistance and Disaster Relief
HF	High Frequency
HLS	Humanitarian Logistics Software
HMMWV	Highly Mobile Multipurpose Wheeled Vehicle
HQMC	Headquarters Marine Corps
IAEA	International Atomic Energy Agency
IGO	Inter-Governmental Organization
IFRC	International Federation of Red Cross and Red Crescent Societies
JRC	Japan Red Cross
JTF	Joint Task Force

KORMAR	Korps Marinir (Indonesia Marine Corps)
LCE	Logistics Combat Element
LHA	Landing Amphibious Assault Ship
LHD	Landing Amphibious Assault Ship
LPD	Landing Platform Dock Ship
LST	Landing Ship Tank Ship
LCAC	Landing Craft Air Cushion
LCU	Landing Craft Utility
LO	Liaison Officer
LOC	Lines of Communication
LTG	Lieutenant General
MAGTF	Marine Air-Ground Task Force
MCAF	Marine Corps Association and Foundation
MCCLL	Marine Corps Center for Lessons Learned
MCPP-N	Marine Corps Pre-positioning Program–Norway
MCWP	Marine Corps Warfighting Publication
MEDIVAC	Medical Evacuation
MEB	Marine Expeditionary Brigade
MEF	Marine Expeditionary Force
MEF-E	Marine Expeditionary Force Enhancement
MEU	Marine Expeditionary Unit
MOA	Memorandum of Agreement
MOOTW	Military Operation Other Than War
MPA	Maritime Patrol Aircraft
MPF	Maritime Prepositioned Force
MPSRON	Maritime Pre-positioning Ship Squadron
MRC	Mobile Radio Communication
MRE	Meals Ready to Eat
MSC	Military Sealift Command
MSOC	Marine Special Operations Company

MTVR	Medium Tactical Vehicle Replacement
NEO	Non-combatant Evacuation Operation
NIPR	Non-secure Internet Protocol Router
NMCB	Navy Mobile Construction Battalion
NGO	Non-Governmental Organization
NTS	NEO Tracking System
NWDC	Navy Warfare Development Command
OECD	Organization for Economic Coordination and Development
PDNA	Post Disaster Needs Assessment
PEP	Prepositioned Equipment Program
PMI	Palang Merah Indonesia (Indonesian Red Cross)
QDR	Quadrennial Defense Review
RAND	Research and Development
RO	Reverse Osmosis
ROV	Remotely Operated Underwater Vehicle
RSO&I	Reception, Staging, Onward movement and Integration
SAR	Search and Rescue
SATCOM	Satellite Communication
SIPR	Secure Internet Protocol Router
SOC	Special Operation Capable
SOP	Standard Operating Procedure
SPMAGTF	Special Purpose Marine Air Ground Task Force
SSB	Single Side Band
STP	Shock Trauma Platoon
TACRON	Tactical Air Control squadron

TNI	Tentara Nasional Indonesia (Indonesia Armed Forces)
TNI AL	Tentara Nasional Indonesia Angkatan Laut (Indonesian Navy)
TNI AU	Tentara Nasional Indonesia Angkatan Udara (Indonesian Air Force)
TNI AD	Tentara Nasional Indonesia Angkatan Darat (Indonesian Army)
UHF	Ultra High Frequency
USAID	United States Agency for International Development
USGS	United States Geological Survey
USMC	United States Marine Corps
USN	United States Navy
VHF	Very High Frequency
VSAT	Very Small Aperture Satellite

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ACKNOWLEDGMENTS

The authors would like to express their sincere appreciation to the people listed below who have provided support, advice, and patience, and who have made this project possible. They were there from its initial concept to its publication.

We would like to extend a special thanks to our wives, Nathalia, Claire, and Rebecca, for their continued support, understanding and encouragement throughout the research and development of this project. Additionally, we thank our children, who good-naturedly accepted the extended hours of our absence. We would also like to thank our advisors, Dr. Aruna Apte and Bryan Hudgens, Lt Col (Ret), USAF, whose guidance and unmatched subject-matter expertise contributed to making us better than we were before. Thank you for your ardent drive and unfailing patience—both of which made the completion of this project possible. Finally, we would like to acknowledge the assistance we received from Major Isarisnawan, Indonesian Marine Corps HQ in Jakarta, for conducting numerous fact-checking operations to ensure the validity of this project.

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I. INTRODUCTION

A. MOTIVATION

Increasing global instability coupled with increasing military budgetary constraints has prompted the Department of Defense (DOD) to revise the 2014 Quadrennial Defense Review (QDR). This revision listed peacekeeping operations, humanitarian assistance, and disaster relief as top priorities in providing long-term global security and economic stability. These operations support the strategic objective to build global security by projecting U.S. influence and deterring aggression as outlined in the 2012 Defensive Strategic Guidance (United States Department of Defense, 2014). Historically, the execution of proactive measures to reduce global instability, including peacekeeping and HA/DR operations, represents a 66 percent cost reduction when compared to the reactive deployment of conventional forces in to a kinetic environment (Government Accountability Office [GAO], 2007). This preventative solution provides a cost effective means to protect the nation's interest while maintaining a deterrent posture through global power projection.

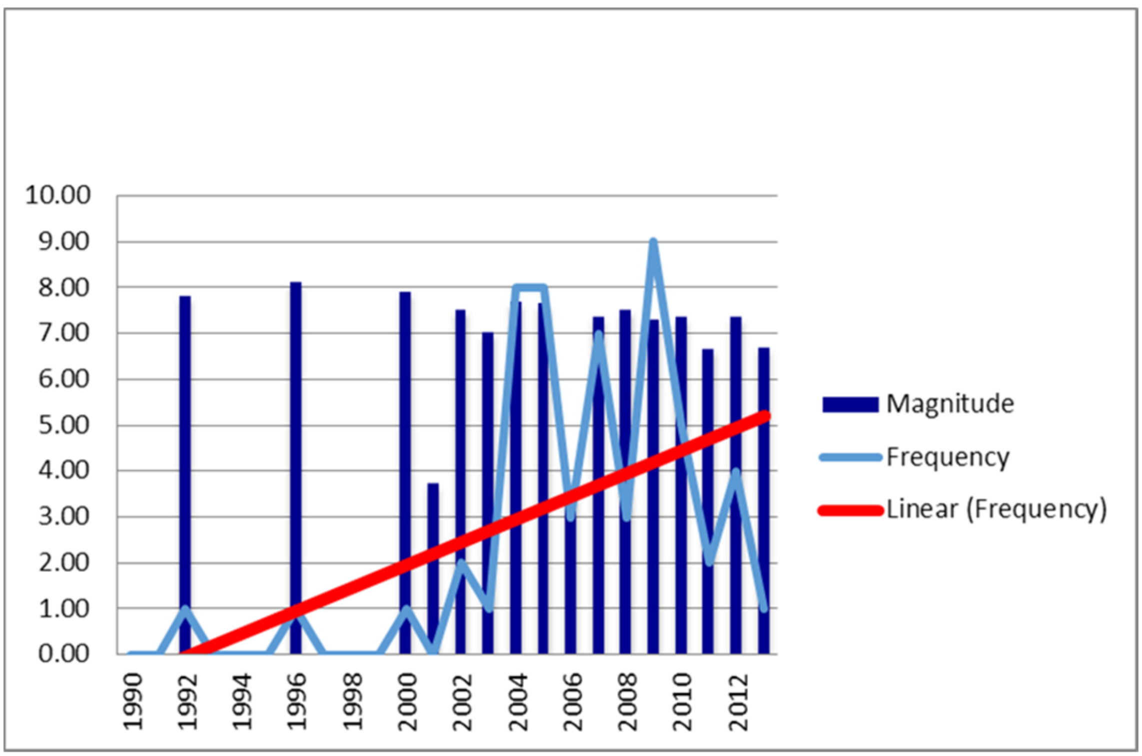
The United States Navy and Marine Corps are structured to provide the critical capabilities necessary to meet non-conventional operations. The attachment of a Marine Expeditionary Group (MEU) to a U.S. Navy Amphibious Ready Group (ARG) will contain at least three surface ships, 30+ aircraft (fixed and rotor wing) and approximately 4,500 Sailors and Marines (HQMC, 2015). An ARG can land a Marine Expeditionary Unit (MEU), Special Operations Capable (SOC), ashore that is able to conduct missions throughout the range of military operations (ROMO). The MEU stands as the primary landing force of the United States and is outfitted with the necessary personnel and equipment to provide an expeditionary rapid response capability that protects national interests (HQMC, 2015). The same capabilities leveraged to respond to enemy threats are also effective at providing critical support during the initial stages of HA/DR operations.

Emerging regional military capabilities, rapidly expanding commerce and geo-political interests have created a dynamic environment within the Asia-Pacific region.

Potential for instability within this region is accentuated by constant threat include earthquakes, tsunamis and typhoons. The Federal Emergency Management Agency (FEMA) defines a disaster as an event resulting in 100 human deaths or injuries or $1 million in damage (Apte, 2009).

Developing nations that are unprepared for natural disasters experience catastrophic losses, which increases their vulnerability to adversarial influence. Earthquake frequency and magnitude data gathered from the International Disaster Database (EM-DAT) for the Indonesia/Sumatra region is shown in Figure 1. This data demonstrates a relatively constant magnitude with an increasing frequency.

Figure 1. Illustration of the Patterns of Seismic Activity in the Indonesian / Sumatra Region



Adapted from EM-DAT, "Indonesia and Sumatra earthquakes frequency and magnitude," 2012, http://www.emdat.be/database.

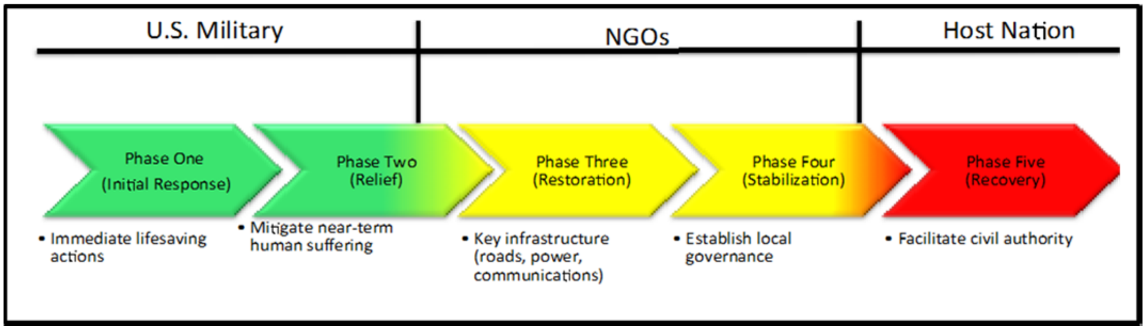
To mitigate this threat, Indonesia is increasing its involvement in disaster relief operational missions with their armed forces while continuing to leverage the international community for advanced warning systems for earthquakes and tsunamis. Indonesia is also the founding member of a multilateral security architecture, which includes the Philippines, Thailand, Malaysia and Singapore (ASEAN, 2015). This created the Association of South East Asian Nations (ASEAN) Asia-Pacific region. The support for the ASEAN from the United States includes a 60 percent increase of naval assets operating in the Asia-Pacific region by 2020 (QDR, 2014). This pivot will facilitate "HA/DR, partnerships capability building, counter-piracy, search and rescue, and bilateral and multilateral confidence-building" (Bower et al., 2015, p. 35). The Marine Expeditionary Unit (MEU) is an essential subcomponent in this strategic effort and provides a wide range of options to cater to specific needs.

Vulnerabilities exhibited by developing countries exposed to natural disasters drive the need for the efficient implementation of HA/DR response activities. This leads us to believe that despite the regional gains in HA/DR preparedness, in the event of a significant natural disaster in the Sumatra or Indonesian region there will be a shortfall of capabilities and resource in the humanitarian assistance and disaster relief supplied by the Indonesian Navy. Once identified, one of the best strategies will be to reduce this gap through the tailored loading and pre-positioning of USMC MEU and Maritime Prepositioned Assets.

B. BACKGROUND

This project aims to identify and compare the critical requirements for HA/DR operations in relation to the capabilities provided by MEU, Maritime Prepositioned Forces (MPF) and Indonesian Naval assets. The methodology used to capture and analyze this information was derived from the traditional concept of supply and demand, applied to a five phase operational template. Phase-one of HA/DR operations concentrates on life-saving efforts while phase two focuses on relief operations to include the distribution of supplies and the restoration of critical infrastructure elements such as electricity and roadways. Phases three through five are centered on restoration, stabilization, and recovery efforts after the departure of supporting military forces from the affected region. Figure 2 is a linear depiction of these five phases, but in practice there is a potential for significant overlap in scope and resource allocation throughout each phase transitions.

Figure 2. The Five Phases of HA/DR Operations



Adapted from Cecchine et al., "The U.S. Military Response to the 2010 Haiti Earthquake –Considerations for Army Leaders," *RAND*, 2013, http://www.rand.org/RAND_RR304.pdf.

The capabilities and assets of the Amphibious Ready Group (ARG) and MEU can support these phases in a limited capacity. Phase one operations focus solely on the preservation of human life and therefore require extensive medical support. Medical personnel, equipment, facilities and transportation account for the bulk of requirements during this phase and are the most critical elements in HA/DR operations. The duration and extent of supporting operations was determined by analyzing recent HA/DR operations (Cecchine et al., 2013). A United States response to HA/DR operations is initiated by the supported nation. This request can come through the State Department or through an existing Memorandum of Agreement (MOA) in which support for HA/DR has been previously agreed upon between the United States and the supported nation. While the President and the Secretary of Defense authorize the use of military assets to support HA/DR operations, the regional combatant-commander has the authority to determine the suitable forces and supporting assets that will be dedicated to individual responses.

II. METHODOLOGY

A. SCOPE

The goal of our research project is to identify and compare the expected demand of a notional, yet regionally probable, HA/DR scenario with the available supply and current response capabilities of the Indonesian Navy and the USMC MEU. We identified capability gaps by utilizing historical data combined with an analysis of current organizational capabilities. Indonesia's potential assistance requirement is captured by three major HA/DR events: the 2004 Indian Ocean earthquake and tsunami, the 2006 Yogyakarta earthquake and the 2009 Padang earthquake. This examination is augmented by a review of the current response capabilities of the Indonesian Navy to determine a notional scenario for anticipated demand. Additionally, our analysis includes the USMC operational response to the 2010 Haiti earthquake, the 2011 Tohoku earthquake and tsunami in Japan, and the 2015 Nepal earthquake. These operations highlight the recent capabilities of the U.S. Marine Corps with an emphasis on the MEU as the first responder to HA/DR scenarios. The first study provides demand data and the second study provides potential supply data. Comparing the two will identify supply shortfalls of the affected region, the *gap*.

B. DATA COLLECTION

Our analysis of Indonesian and USMC Operations includes open source After Action Reports (AARs), case studies, and lessons learned from historical HA/DR operations. HA/DR demand data is collected from disasters in the Indonesian region. Organizational data for the Indonesian Navy, Tentara Nasional Indonesia Angkatan Laut (TNI AL) and United States Marine Corps MEU is gathered from open-source archives and compiled in order to identify potential HA/DR gaps between supply and demand.

C. LITERATURE REVIEW

The last decade has shown a dramatic rise in global humanitarian disasters. These disasters range from earthquakes and floods, to drought, famine, civil war and viral epidemics. A similar increase has taken place within the research, published literature, and planning between nations in order to detect and respond to these disasters. The Naval Warfare Development Center (NWDC) breaks Humanitarian Assistance and Disaster Relief (HA/DR) into the following components:

1. Humanitarian Assistance

The Navy Warfare Development Command (NWDC) defines humanitarian assistance as, "programs conducted to relieve or reduce the results of natural or manmade disasters or other endemic conditions such as human pain, disease, hunger, or privation that might present serious threat to life or that can result in great damage to or loss of property" (NWDC, 2005, p. 3 of glossary).

2. Disaster Relief

The NWDC also defines disaster relief as "prompt aid that can be used to alleviate the suffering of disaster victims. Normally it includes humanitarian services and transportation; the provision of food, clothing, medicine, beds and bedding; temporary shelter and housing; the furnishing of medical material and medical and technical personnel; and making repairs to essential services" (NWDC, 2005, p. 2 of glossary).

Of the documented global disasters, over 60% have taken place in the Asia-Pacific region (Moroney, Pezard, Miller, Engstrom, & Doll, 2013). With the total number of events on the rise, and the preponderance of these events taking place in the Asia-Pacific region, we have focused our research on the collaborative response potential of the TNI AL and the USMC MEU when dealing with HA/DR events.

Throughout our studies, the literature is conclusive that conducting any HA/DR mission is difficult and complex. Additional themes discussed throughout our research include:

- Asset pre-positioning and infrastructure development for assistance in disaster response.

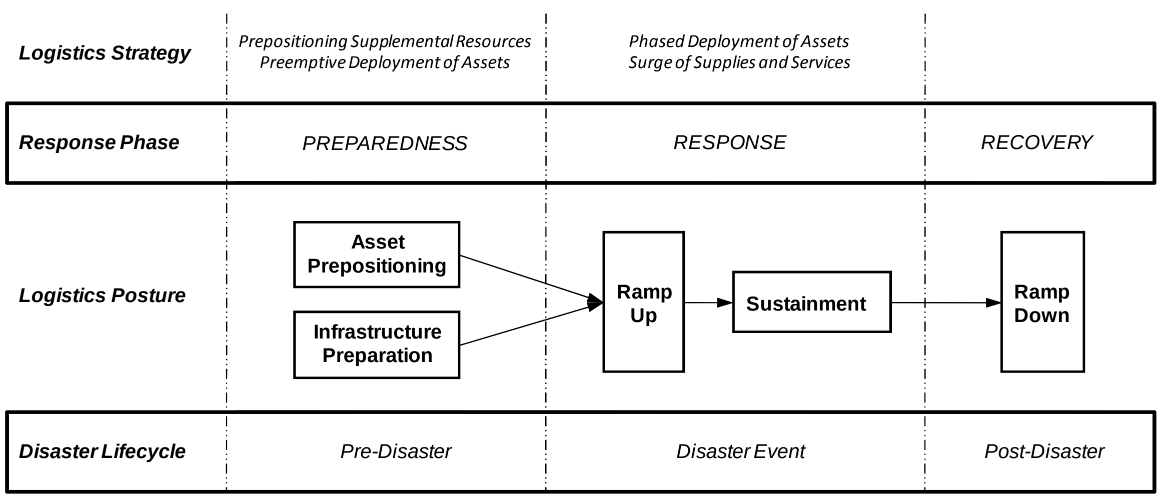
- Understanding capabilities and competencies of responding units and dissemination this information prior to the HA/DR event.

- Mission success often relies upon the establishment of cooperative and collaborative relationships and networks to include public-private sector cooperation, military-nonmilitary cooperation, and military-military partnerships.

3. Pre-positioning and Preparation

Response to disaster operations is typically dependent on the logistic flow of relief items through a response supply chain system. The humanitarian logistics process can be divided into three parts. These include the preparedness before the occurrence of a disaster, an immediate response after the occurrence of a disaster, and the enduring recovery effort post-disaster (Apte, 2009). Figure 3 graphically depicts this three tiered model.

Figure 3. Timeline of the Humanitarian Supply Chain



Adapted from Apte, A., "Humanitarian logistics: A new field of research and action." *Foundations and Trends in Technology, Information, and Operations Management*, 3(1), 1–100. doi: 10.1561/0200000014, 2009.

Strategic preparedness initiated prior to the onset of a natural disaster is essential to the successful execution of HA/DR response operations. Figure 3 is depicting asset pre-positioning, infrastructure preparation and the development of analytical models as components of the preparedness phase (Salmeron & Apte, 2009). Mitigation is the fourth step in the disaster management cycle, and serves as precursor to preparedness, response, and rehabilitation (Tomasini & Wassenhove, 2009). Mitigation is most beneficial when dealing with non-natural disasters and can include the diplomatic prevention of wars, agricultural innovations to reduce the risk of famine, the stabilization of currencies and any other way to preempt and avoid a humanitarian disaster.

a. Asset Pre-positioning

Pre-positioning is especially useful when disasters are seasonal or predictable in location (Apte, 2009). The United States military has an afloat pre-positioning program through its Military Sealift Command (MSC) that "places military equipment and supplies aboard ships located in key ocean areas to ensure rapid availability during a major theater war, a humanitarian operation or other contingency" (MSC, 2015). MSC pre-positioning ships primarily contain military equipment, some of which is suitable for HA/DR response. Within the United States, the Federal Emergency Management Agency (FEMA) created a Prepositioned Equipment Program (PEP) in 2001 to provide supplies in 10 geographic locations. These modules were designed to provide expedited response to national disasters or terrorist attacks. Each of the geographic locations contained standardized equipment pods. "Currently, each pod contains personal protective, decontamination, detection, technical search and rescue, law enforcement, interoperable communications and other emergency response equipment, capable of outfitting firefighters, law enforcement and emergency medical personnel" (FEMA PEP, 2012). In 2012, an internal review was conducted of PEP with recommendations for revision or removal of the program on a cost / benefit analysis decision. ASEAN countries have discussed a pre-positioning program for HA/DR response and have warehouses located in multiple locations for the consolidation and distribution of emergency supplies, but have not formally begun this process.

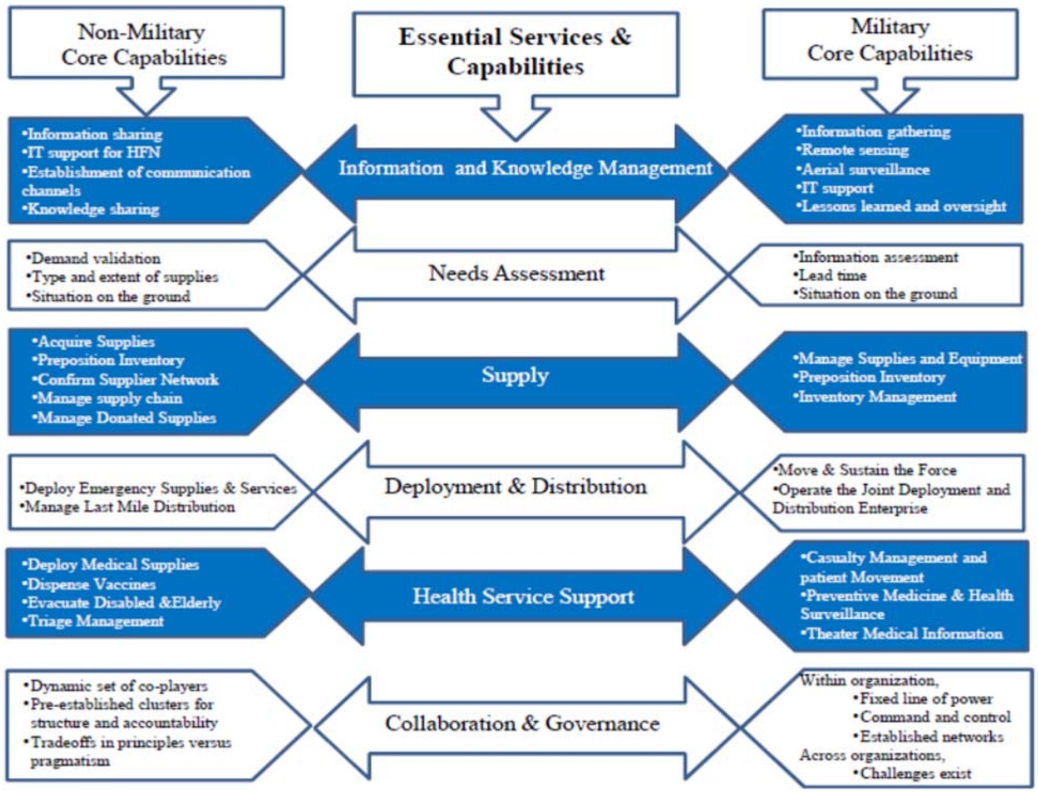
b. Infrastructure Development

Prior to a disaster, preparedness activities should be done with all parts and components of communities (Coppola, 2011). Organizations, individuals, emergency response agencies, government officials, business players, and citizens are components that should conduct preparedness activities to reduce the impacts of disasters (Coppola, 2011). The collective approach to preparation involves improving existing roads, bridges, air and seaports, as well as the creation and implementation of disaster early warning and communication systems. The National Research Council (NRC) defines resilience as “the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events” (NRC, 2015). Examples of this resiliency can include the creation of Emergency Operations Plans (EOPs), Standard Operating Procedures (SOPs), and conducting training and exercises.

4. Capabilities and Competencies

The response to an HA/DR scenario involves members of the affected country, external militaries, and Non-Governmental Organizations (NGOs). These organizations includes separate ministries and administrations within a government, distinct branches of militaries, and a large number of separate NGOs and aid organizations. The appropriate application of each organization’s inherent capabilities increases the effectiveness of HA/DR response. Six primary essential services and capabilities in a HA/DR scenario are identified by Figure 4 (Apte & Yoho, 2012).

Figure 4. Humanitarian and Military Core Competencies



Adapted from Apte & Yoho, "Capabilities and competencies in humanitarian operations (NPS-LM-12–175)," *NPS Archives,* 2012, http://www.acquisitionresearch.net/files/FY2012/NPS-AM-12–175.pdf.

5. Cooperation and Collaboration

Our research focuses on the cooperation and collaboration required to conduct a joint HA/DR response mission led by the Indonesian Navy and the United States Marine Corps. Indonesia is frequently struck by natural disasters affecting a significant portion of their population. The United States Military has assets forward deployed and based within the United States capable of HA/DR response. Unique assets including ships, trained personnel and a willingness to assist in international relief operations will allow the United States to remain a major player in disaster relief response situations (Moroney et al., 2013). When the MEU is forward deployed during contingency operations they are expected to accomplish the following primary functions: "conducting amphibious operations, crisis response and limited contingency operations, to include enabling the introduction of follow on forces, and, designated special operations, in order to support the theater requirements of Geographic Combatant Commanders (GCC)" (USMC, 2009, p. 4). To prepare for these deployment operations, training exercises are conducted to ensure that the Marines and Sailors are capable of performing vital HA/DR specific mission sets which include, Noncombatant Evacuation Operations (NEO) and Humanitarian Assistance (24th MEU, 2015).

Indonesia has created HA/DR guidelines to ensure that TNI AL adheres to regulations of the Indonesian Armed Forces Commander. This regulation directs the cooperation between the Indonesian armed forces and the militaries of other countries in disaster relief efforts (Tentara Nasional Indonesia [TNI] Commander Regulations, 2009). The Government of Indonesia (GoI) uses the Indonesian Armed forces to mitigate the effects of natural disasters. The GoI also requests HA/DR assistance through external organizations and allied militaries (TNI Commander Regulations, 2009). TNI AL integrates foreign military aid by establishing Liaison Officers (LNOs) for naval warships or Marine Corps units of foreign countries. After LNO integration, maps of both sea and land approaches at the disaster site are created and promulgated. Next, anchorage positions, a description of the shoreline, and the nearest resupply port are established. Lastly, warships, marine and air units are prepared and deployed to support the HA/DR response. Additionally, communication networks must be established and coordinated with all responding parties through the Disaster Emergency Response Command (TNI Commander Regulations, 2009).

The USMC MEU and the Indonesian Navy have developed pre-disaster training and post-disaster reaction plans to mitigate many of the difficulties in coordinating a humanitarian disaster response. We believe that additional study of the capabilities of both nations will identify potential gaps in supply and demand and increase their response effectiveness during a HA/DR mission.

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III. HA/DR DEMAND IN SOUTH PACIFIC REGION

A. INTRODUCTION TO HA/DR DEMAND

In this chapter, we analyze three HA/DR operations in the South-Pacific region to identify demand patterns and project critical requirements during the initial phases of disaster response operations. The 2004 Indian Ocean tsunami provides the historical context relating to the importance of communication in reducing medical requirements and providing sustenance to the local populace. The 2006 Yogyakarta earthquake demonstrates how improvements in logistical support directly impact the distribution of essential goods. Finally, the 2009 Padang earthquake provides insight on the importance of airlift capabilities.

B. INDIAN OCEAN TSUNAMI (2004)

Historical data highlights the influence that sustained cultural resiliency has in areas plagued by reoccurring natural disasters. In 2004, the Indian Ocean tsunami resulted in millions of dollars damages yet only 7 people were killed on the mostly native Simeulue Island. The high tourist population in Aceh Besar however, resulted in thousands of casualties. The large variation in the death toll between these two areas can be attributed to the cultural resiliency. The knowledge and experience gained from the tsunami of 1907 by local elders was passed throughout the island population, which prompted the locals to seek shelter from the impending tsunami in 2004 (McAdoo, Dengler, Prasetya & Titov, 2006). The inhabitants of Jantho lacked the cultural resiliency of the Simeulue population, and as a result, suffered far more casualties. Today, communication technology including early warning and mass populace notification systems can initiate immediate response measures and provided critical information during disasters.

The 2004 earthquake and tsunami also exposed additional shortfalls related to the logistic distribution of critical supplies. Indonesian had insufficient infrastructure to respond to the 2004 disaster, particularly to conduct the last-mile distribution of aid material. The ability to provide sustainable, last-mile logistics management and the use of commercial supply chain assets to facilitate disaster management operations were key capabilities required by Indonesia to better respond to future disasters (Economist Intelligence Unit [EIU], 2005). In this case, the implementation of logistic distribution systems shows the vital role of military employment followed by Inter-Governmental Organizations (IGOs) then Non-Governmental Organizations (NGOs) locally and internationally. Many lessons learned from this incident include the ability to provide sustainable, last-mile logistics management and the use of commercial supply chain assets to further facilitate disaster management operations based on the scale of the disaster (EIU, 2005).

Another important aspect of effective relief efforts concerns the immediate care of affected populations including mortuary affairs, and the provision of food, water, clothes, shelter, medical care, and counseling (Fritz Institute, 2005a, 2005c).

Table 1 is an illustration that the largest percentage of aid received was provided by private individuals within the first 48 hours of humanitarian response. Comparatively, the government and religious organizations provided much smaller contributions, while the corporate sector provided little to no HA/DR response. Additionally, our research revealed that the initial relief efforts were slow to build temporary shelters, resulting in millions of displaced persons over a nine month period. This situation was further exacerbated by a lack of heavy equipment, rotary airlift and ground logistical support during the reestablishment of habitat, sustenance and infrastructure. Lastly, the lack of emergency planning and the restoration of lines of communication further prevented the efficient HA/DR response (TNI Information Center, 2005a).

The number of victims based on category and location as a result of the 2004 Indian Ocean earthquake and tsunami are shown in Table 2. This information is utilized when making a comparison with the 2006 Yogyakarta and 2009 Padang earthquakes.

Table 1. Affected Families Recall Service Providers during the First 48 Hours Post-disaster in Aceh Province*

	Services Provided							
Service Providers	Rescue	Burial of dead	Food	Water	Clothes	Shelter	Medical care	Counseling
Government	5	2	6	4	4	8	10	3
International NGO	1	1	1	1	1	1	3	4
Local NGO	2	2	2	1	2	1	1	1
Private Individual	91	88	88	93	86	87	74	78
Corporate Sector	0	0	0	0	0	0	0	0
Religious Organizations	1	7	22	1	7	2	13	1

* Numbers are presented in percentage (%). Adapted from Fritz Institute, "Recipients perceptions of aid effectiveness: Rescue, relief, and rehabilitation in tsunami affected Indonesia, India and Sri Lanka," 2005b, http://www.fritzinstitute.org/NineMonthReport.pdf.

Table 2. Affected Populations in the 2004 Indian Ocean Earthquake and Tsunami, Aceh Province

	The 2004 Indian Ocean Earthquake and Tsunami				
District Name	**Death**	**Missing**	**Injured**	**Suffered**	**Displaced**
SIMEULUE	7	1	1	1	22849
ACEH SINGKIL	0	28	28	28	0
ACEH SELATAN	6	0	0	0	17630
ACEH TENGGARA	26	146	146	146	0
ACEH TIMUR	224	0	0	0	2356
ACEH TENGAH	192	7	7	7	4005
ACEH BARAT/MEULABOH	11830	3024	3024	3024	59584
ACEH BESAR	47784	0	0	0	116984
PIDIE	4646	1463	1463	1463	31078
BIREUEN	1202	59	59	59	26758
ACEH UTARA	2238	488	488	488	28268
ACEH BARAT DAYA	9	0	0	0	13600
GAYO LUES	3	0	0	0	293
ACEH TAMIANG	0	4	4	4	3100
NAGAN RAYA	493	845	845	845	10659
ACEH JAYA	19661	143	143	143	29273
BENER MERIAH	10	0	0	0	1204
PIDIE JAYA	77804	0	0	0	34146
BANDA ACEH	12	2	2	2	3939
SABANG	0	0	0	0	10370
LANGSA	394	10	10	10	20084
LHOKSEUMAWE	85436	85436	85436	85436	85436
SUBULUSSALAM	34064	34064	34064	34064	34064
TOTALS	286041	125720	125720	125720	555680

Adapted from Indonesia National Board of Disaster Management (Badan Nasional Penanggulangan Bencana), "Indonesia Natural Disasters Data," 2015,http://dibi.bnpb.go.id/data-bencana/lihat-data.

C. YOGYAKARTA EARTHQUAKE (2006)

On May 27, 2006, a 6.3-magnitude earthquake struck the Yogyakarta region of Indonesia resulting in over 600,000 of displaced inhabitants. Palang Merah Indonesia (PMI) provided initial disaster response by distributing surplus supplies from the 2004 and 2005 tsunamis. This material provided critical supplies for 1,000 families and established the foundation for follow-on supply chain operations (Charles, Gatignon, & Van Wassenhove, 2011).

Emergency Response Units (ERU) provided personnel and equipment support, which greatly assisted the coordination and distribution of essential supplies. The rapid restoration of the Yogyakarta International Airport and the availably of supporting equipment proved were listed as essential elements during the first 48 hours of response operations. The lack of a centralized warehouse to store essential goods also placed a huge strain on logistic operations. By June 7, PMI and ERU personnel had established a robust supply chain to process and deliver the influx of in-kind donations. Humanitarian Logistics Software (HLS) and the Disaster Management and Information System (DMIS) standardized and consolidated record keeping procedures and ensured strict adherence to the established standard processes (Charles et al., 2011).

These efforts resulted in a 50 percent improvement in number of families who received partial supply packages within the first two months of response operations with compared to 2004 tsunami. Days to activate end to end supply chain was decreased by 15 days, while order lead time was reduced from 30 to 16 days (Charles et al., 2011). The improvements experiment the 2006 Yogyakarta earthquake demonstrates the importance of logistical support equipment, personnel and communication.

D. PADANG EARTHQUAKE (2009)

On September 30, 2009 a 7.6 magnitude earthquake of the coast of Sumatra, Indonesia. The resulting damage prompted the Indonesian government to request assistance from the U.S. government, who subsequently assigned U.S. naval forces to provide aid to the local population. Lessons learned from this event highlighted the benefits of airlift assets to assist in delivering supplies and medical personnel to the effected population.

Initial vertical lift shortfalls coupled with limited ground distribution routes resulted in the inadequate distribution of relief supplies like water, food, blankets or tarps, and medical services (TNI Information Center, 2009). On October 3, the USS Denver arrived along with components of the 31st MEU and began providing direct relief support. Vertical lift assets from the 31st MEU and the Tactical Air Control Squadron 12 (TACRON 12) conducted surveys to provide damage assessments of the effected region and identify potential landing zones in isolated regions (O'Connor, 2012).

Their efforts facilitated the prioritization of relief efforts and established a base for follow-on air relief operations. Within the first 13 days of U.S. supported relief operations, CH-53 helicopters had conducted over 150 sorties to deliver 640,000 pounds of supplies, and transported 1,117 personnel for medical treatment (O'Connor, 2012).

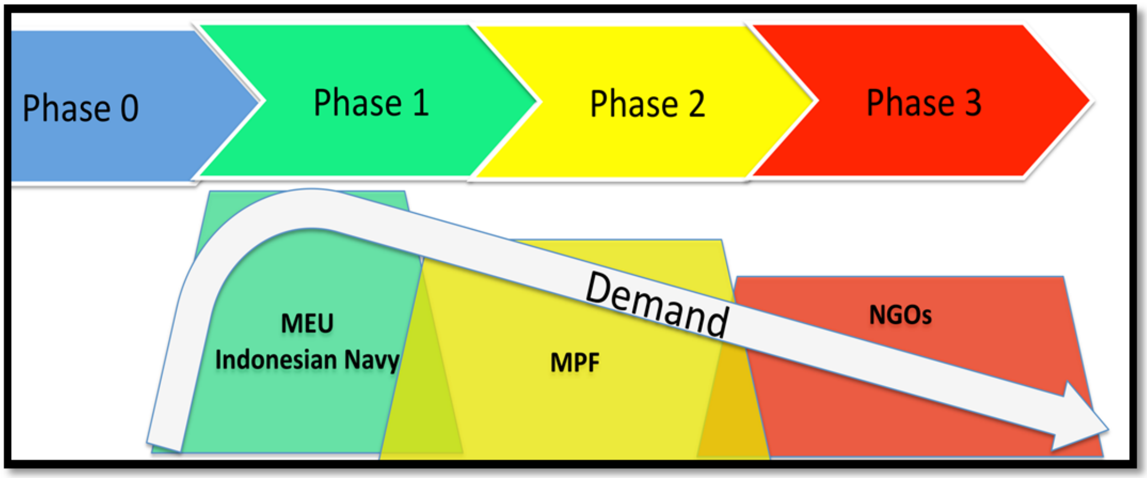
IV. CAPABILITIES AND RESPONSE

A. INTRODUCTION TO HA/DR SUPPLY

Determining the optimal response measures for HA/DR related demand begins by identifying the available organic assets and capabilities of the Indonesian Navy and the United States Marines Corps. It is important to note that supply capability extends across all phases of HA/DR operations and include "procurement, staging, warehousing, and managing of inventory to support the disaster response" (Apte & Yoho, 2012, pp. 7–8).

Figure 5 is an illustration of the application of critical resources during a natural disaster. Peak demand is normally experienced at the onset of an event and gradually declines as relief operations continue. Overlaps during transitional phases ensure the uninterrupted application of relief efforts and is essential to mission success. Our research focused on inventory management activities conducted during phase one operations; the deployment of necessary personnel, material, logistics and communication assets; and capabilities needed to meet critical demand requirements. Critical personnel are defined as essential members from both the Indonesian Navy and the United States Marine Corps whose military occupation directly supports HA/DR operations. Material assets are listed as the supplies and equipment needed to meet medical relief, sustenance, habitat and infrastructure requirements. The logistics component encompasses the elements related to the coordination and execution required for the distribution of material and the transportation of personnel and equipment, while the communication capabilities focus on the requirements needed to establish and maintain collaborative networks.

Figure 5. HA/DR Operational Phases and Associated Demand



Adapted from Cecchine et al., "The U.S. Military Response to the 2010 Haiti Earthquake—Considerations for Army Leaders," *RAND*, 2013, http://www.rand.org/RAND_RR304.pdf.

Once identified, these four components can be listed and weighted based on their ability to support the spectrum of critical demand requirements, as shown in Table 3.

Table 3. HA/DR Response Capability Matrix

		Capabilities			
		Personnel	**Material**	**Logistics**	**Communication**
Supply Criteria	**Medical**				
	Sustenance				
	Habitat				
	Infrastructure				

The reference template shown in Table 3 captures and presents quantitative or qualitative aspects of supply and demand for a multitude of responders and response organizations. Supply criteria is prioritized in descending order based on the criticality of the required service. Medical requirements are limited to the assets, which pertained directly to life-saving measures required within the first five days of a disaster. Sustenance contains the minimal food and water required to prevent the loss of life from dehydration and starvation. Habitat includes the necessary shelter and hygienic resources required to prevent the loss of life from exposure to the elements or unsanitary conditions.

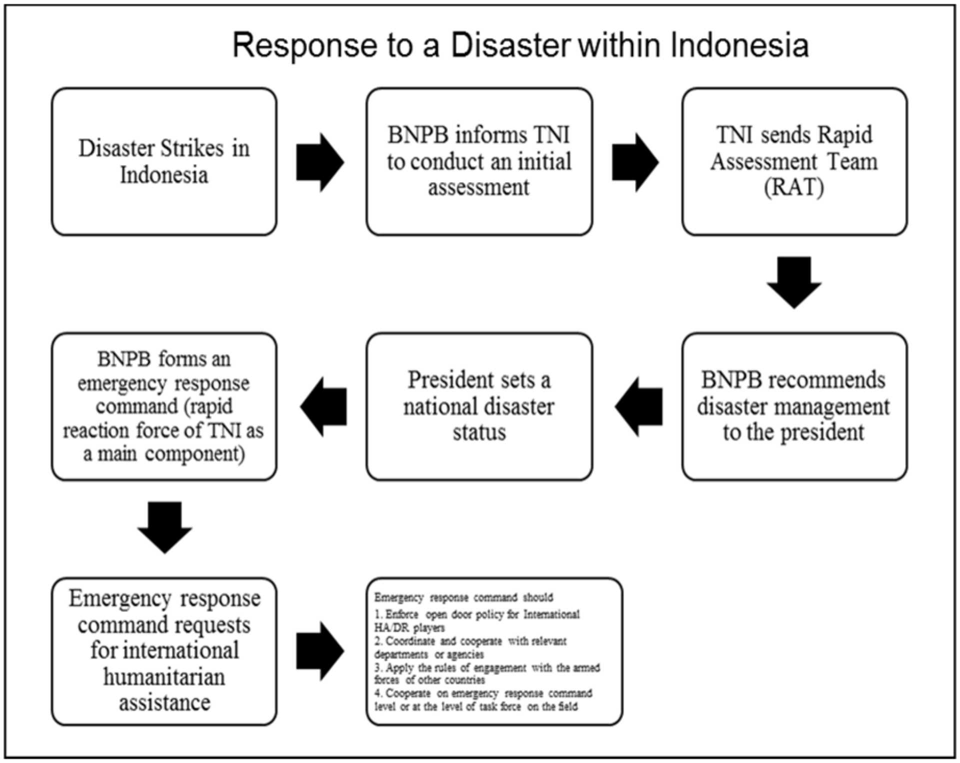
B. INDONESIAN NAVY

The Indonesian Navy (Tentara Nasional Indonesia Angkatan Laut [TNI AL]) consists of several components including two naval fleets, two Marine Corps groups, and a naval air arm. The total strength of TNI AL is around 65,000 personnel and is comprised of 44,000 sailors, 20,000 marines, and 1,000 naval airmen. TNI AL has been enhancing their capacity and capability in recent years through the procurement of new ships, amphibious tanks, anti-submarine warfare helicopters, and maritime patrol aircraft. These products are both built locally and imported from allied countries. The mission of TNI AL is to protect Indonesia's vast maritime territory and resources. Additional missions conducted by TNI AL include improving their strategic sealift capacity provide enhanced response to natural disasters and for the transport of marine and army ground forces throughout the region (Jane's, 2015a).

In disaster relief operations, TNI AL collaborates as combined forces with the Indonesian Air Force (Tentara Nasional Indonesia Angkatan Udara [TNI AU]) and the Indonesian Army (Tentara Nasional Indonesia Angkatan Darat [TNI AD]). In this mission, they use assets owned by each service. All disaster relief operations are considered joint endeavors of the Indonesian Armed Forces (Tentara Nasional Indonesia [TNI]) in their support to the Indonesian National Board of Disaster Management (Badan Nasional Penanggulangan Bencana [BNPB]). Though their involvement must wait until it has been requested by the BNPB, TNI will always be the primary response organization in any disaster relief operations.

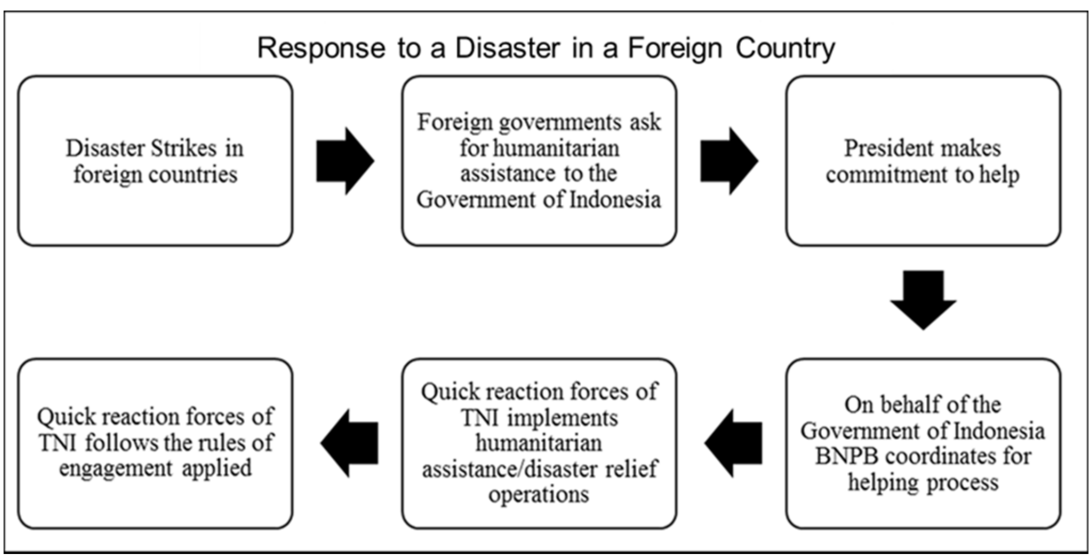
Figures 6 and 7 depict the scheme for organizing disaster relief cooperation in Indonesia and between Indonesia and foreign countries. These figures were published in the *Manual of TNI Cooperation with Military of Other Countries in the Field of Disaster Relief, 2009*. The next section will categorize and define equipment owned by the TNI AL and their subordinate forces that can be utilized in the Humanitarian Assistance/Disaster Relief (HA/DR) operations.

Figure 6. Military Response to Disasters within Indonesia



Adapted from Indonesian Armed Forces (TNI) Commander Regulations, “The manual of the Indonesian armed forces cooperation with the military of other countries in the field of disaster relief,” 2009.

Figure 7. Military Response to Disasters in a Foreign Country



Adapted from Indonesian Armed Forces (TNI) Commander Regulations, “The manual of the Indonesian armed forces cooperation with the military of other countries in the field of disaster relief,” 2009.

1. Naval Warships

TNI AL plays an important role in maintaining security throughout the archipelago of Indonesia. The role of TNI AL during wartime is to cooperate with the Indonesian Air Force while interdicting potential threats as far forward as possible. This deep interdiction is designed to prevent foreign incursion and threatening the population center of Indonesia while simultaneously securing the sovereign exclusive economic zone (EEZ). In peacetime, TNI AL has a principal responsibility of thwarting illegal fishing, smuggling, piracy, and to support domestic operations. These domestic operations includes HA/DR support in response to natural disasters. TNI AL has two major fleets with tactical commands in Jakarta and Surabaya. The Western Fleet Command in Jakarta covers waters that are in the western region of Indonesia encompassing Sumatra Island, the Strait of Malacca, islands in Riau, the western part of Java and Borneo Islands. The Eastern Fleet Command in Surabaya protects all waters that are in the eastern part of Indonesia including the eastern part of Borneo Island, Sulawesi Islands, Nusa Tenggara Islands, and islands in Maluku, Papua, and the Arafura Sea. The number of warships deployed in the eastern region is much larger than the west as it encompasses a much more extensive waterway. The number of ships in the western and eastern fleets in service is shown in Table 4.

Table 4. Indonesian Naval Ships in Service in the Western and Eastern Fleets

No.	Ship class	Unit	Helo onboard
1.	Landing Platform Dock (LPD) Hospital ship	1	2 helos
2.	LPD Makassar Class	2	2 helos
3.	LPD Banjarmasin Class	2	3 helos
4.	Landing Ship Tank (LST) Teluk Semangka Class	5	1 helo
5.	LST Teluk Bintuni Class	1	2 helos
6.	LST Frosch Class	11	-
7.	Submarine Cakra Class	2	-
8.	Frigate (FFG) Ahmad Yani Class	6	1 helo
9.	FFG Ki Hajar Dewantara Class	1	1 helo
10.	FFG Bung Tomo Class	3	1 helo
11.	Corvette Diponegoro Class	4	1 helo
12.	Corvette Fatahillah Class	3	1 helo
13.	Corvette Kapitan Patimura Class	14	-
14.	Fast Attack Craft Missile (FACM) Mandau Class	4	-
15.	Fast Attack Craft Torpedo (FACT) Singa Class	2	-
16.	Fast Attack Craft (FAC) Clurit Class	12	-
17.	FACM Sampari Class	3	-
18.	FACM Salawaku Class	2	-
19.	Fast Patrol Boat Missile (FPBM) Todak Class	4	-
20.	FPB Kakap Class	4	1 helo (SAR)
21.	Patrol Craft (PC) 36	13	-
22.	PC Sibarau Class	8	-
23.	PC 40	10	-
24.	PC 43	3	-
25.	Mine-counter Measure Vessel (MCMV) Pulau Rengat Class	2	-
26.	MCMV Condor Class	9	-
27.	Auxiliary	3	Oiler and water

Numbers presented show all helicopters onboard, including warships that can facilitate helicopter airlift and transportation. Adapted from Saunders, “Jane’s Fighting Ships 2014–2015,“ *IHS Global Limited*, 2015.

The first five warships listed in Table 4 provide a vital role in HA/DR operations. Landing Platform Dock (LPD) ships carry up to three helicopters when underway. This type of ship also has two Landing Craft Utility’s (LCUs) used as multi-purpose logistics vessels. The LCUs can operate at speeds averaging 30 knots. LCUs can also transfer 150 fully equipped military personnel or 120 personnel and one 5-ton truck. The Landing

Ship Tank (LST) has a major role in amphibious operations and is also suitable to carry logistics for HA/DR operations because of a spacious hold and storage capacity. The LST storage capacity can quickly be converted from its primary mission of transporting Indonesia's main battle tanks to moving up to 650 tons of HA/DR supplies. This type of ship is also able to carry two helicopters to increase its ability to support the amphibious forces (Saunders, 2015).

2. Indonesian Marine Corps

The Indonesian Marine Corps (Korps Marinir [Kormar]) is a subordinate component command of the Indonesian Navy. They have two marine groups and one infantry brigade. Each marine group includes a brigade of three battalions, a cavalry regiment with tank and reconnaissance units, and a combat support regiment with engineer, communication, supply, air defense, landing craft, transport and medical units. The stand-alone infantry brigade lacks cavalry and combat support units. The Indonesian Marine Corps is headquartered in Jakarta. The first group command headquarters is based in Sidoarjo (East Java) and covers Indonesia's eastern region while the second group is based in Jakarta and covers Indonesia's central and western regions. In addition to these two groups, the standalone infantry brigade is the initial phase of the development of a third group (Jane's, 2015a). The Indonesian Marine Corps is a major player in any HA/DR response by providing ground forces to augment the army. The primary type and number of equipment in service with the Indonesian Marine Corps can be found in Table 5.

Table 5. Indonesia Marine Corps Equipment in Service

No	Vehicle type	Inventory	Maximum load
1.	Truck		
	a. Light	48	Up to 2,000 kg
	b. Medium	293	2,000 kg–4,500 kg
	c. Heavy	122	4,500 kg–8,000 kg
	d. Water tank	8	Up to 8,000 liters
	e. Fuel tank	12	Up to 8,000 liters
	f. Dump truck	8	Up to 34,000 kg
2.	Trailer		
	a. Toilet/restroom portable	2	
	b. Water	7	Up to 10,000 liters
	c. Cargo (20 feet container)	7	Up to 21,800 kg
3.	Heavy Equipment		
	a. Dozer	1	
	b. Bulldozer	2	
	c. Hough loader	1	
	d. Crane	1	
	e. Excavator	4	
	f. Road roller	1	
	g. Front loader	2	
	h. Backhoe loader	3	
	i. Loader	1	
	j. Road grader	1	
	k. Bridge layer	1	
	l. Tractor	1	
	m. Forklift	9	
4.	Prime Mover	12	
5.	Cargo Trailer (40 feet container)	11	Up to 26,680 kg
6.	Ambulance	28	
7.	Firefighting	4	
8.	Water Canon	2	
9.	Workshop	10	
10.	Mobile Communication	6	
11.	Towing Car	2	

Information was initially adapted from Connors & Foss, "Jane's Military Vehicles and Logistics 2005–2006, " *Jane's Information Group Limited,* 2005; Southby & Obe, "Jane's Amphibious and Special Forces, " 2002, https://janes.ihs.com.libproxy.nps.edu CustomPagesJanesDisplayPage.aspxDocType=Reference&ItemId=+++1309125.pdf, and then cross-referenced with information from www.marinir.tnial.mil.id (Indonesia Marine Corps website), www.dephub.go.id (Indonesia Ministry of Transportation website), and additional sources were available. Numbers presented as a maximum load capacity obtained from www.hubdat.dephub.go.id (Directorate General of Land Transportation) and was also cross-referenced when additional sources were available. Last information was adapted from Jane's Information Group, "Jane's Land Warfare Platform–Logistics, Support and Unmanned," 2015c, https://janes.ihs.com.libproxy.nps.edu/ CustomPages/ Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1495023&Pubabbrev=JLSU.

Based on Table 5, the primary issue facing the Indonesian Marine Corps is their vehicle readiness. On average, nearly 35% of their vehicles are down for repairs or awaiting maintenance parts (M. Isarisnawan, personal communication, June 24, 2015).[1] These maintenance issues stem from an aging equipment set, long lead time for repair part acquisition, and a non-standardized mix of vehicles from multiple international vendors. The planning policy of TNI AL in 2016 for the task of military operations other than war (MOOTW) is to help the government respond to natural disasters, displacement, and the distribution of humanitarian aid. In response to this planning policy, the Indonesian Marine Corps is modernizing portions of their equipment inventory in 2016. The Indonesian Marine Corps purchases in 2016 are shown in Table 6.

Table 6. Indonesian Marine Corps Equipment Purchases

No.	Equipment	Unit	Maximum load
1.	Medium Forklift	2	2.5 tons
2.	Heavy Forklift	2	5 tons
3.	Excavator	2	
4.	Loader	1	
5.	Road grader	2	
6.	Fuel-tank truck	4	8,000 liters
7.	Water-tank truck	4	8,000 liters
8.	Hyperbaric chamber	1	
9.	Ambulance car	3	
10.	Crane truck	13	
11.	Firefighting vehicle	2	
12.	Bulldozer	2	
13.	Field hospital	1	
14.	Remotely Operated Underwater Vehicle (ROV)	1	
15.	Reverse Osmosis (RO)	10	

Adapted from Indonesian Navy (TNI AL), "Decisions of the Chief of Navy Staff," *Planning Policy 2016*, March 9, 2015.

[1] This information was conveyed to the authors through voice and electronic communication during our research, summer quarter, Naval Postgraduate School.

Table 6 is a reflection of the FY16 planned purchases for the Indonesian Marine Corps. The purpose of this purchase plan is to leverage the capacity of equipment especially for conducting Military Operations Other Than War (MOOTW) in HA/DR operations. The Indonesian Marine Corps also faces a big challenge in procurement process regarding overlapping tasks with the Indonesian Army. Another challenge encountered by the Indonesian Marine Corps particularly and TNI AL generally is the vast area of responsibility to cover all Indonesian waters.

3. Indonesian Naval Air Component

The TNI AL flight element consists of six components. These components are separated into their core mission capabilities and include:

- 100 Air Squadron, Anti-Submarine Warfare
- 200 Air Squadron, Training
- 400 Air Squadron, Search and Rescue (SAR)
- 600 Air Squadron, Transport and Utility
- 800 Air Squadron, Maritime Patrol Aircraft
- 900 Air Squadron, Repair and Maintenance (Hunter, 2014)

The first component is 100 Air Squadron that has a main duty to conduct Anti-Submarine Warfare (ASW). This unit re-established in 2014 in conjunction with the purchase of the AS-565 Panther anti-submarine helicopter. The decision to re-establish the 100 Air Squadron arose due to the recent proliferation of submarines in Southeast Asian waters. At least ten new submarines have been delivered to regional countries, including Singapore and Malaysia. The increased potential of submarine threats created the need to dedicate this naval aviation squadron with specific training and capabilities in submarine action (Rahmat, 2015). This unit was first formed in July 1961 as a dedicated fixed-wing aircraft ASW and underwent liquidation in the wake an economic crisis affecting Indonesia in 1998.

The 200 Air Squadron service is designed to recruit and train TNI AL pilots for fixed and rotary wing. The 400 Air Squadron is a combat team whose primary mission is Search and Rescue (SAR). The major function of the 600 Air Squadron is as an airlift element conducting general transportation and utility. The 800 Air Squadron serves as the leading component of maritime patrol aircraft (MPA) conducting interoperability operations between air and surface assets. Lastly, the 900 Air Squadron is the primary location of all aircraft maintenance and repair (skuadron600.blogspot.com, 2012). The total number of aircraft in service is summarized by Table 7:

Table 7. Indonesian Naval Aircraft In Service

No.	Aircraft type	Inventory	Remarks
1.	TB-9 Tampico	4	Basic Prop Trainer
2.	TB-10 Tobago	5	Basic Prop Trainer
3.	N-22/N-24 Nomad	25	Maritime Patrol Aircraft (MPA)
4.	NC-212 Aviocar Casa	8	Aircraft Transport and MPA
5.	NC-235 AirTech Casa	5	Aircraft Transport and MPA
6.	NBO-105CB Bolcow	6	Helo Transport, Search and Rescue (SAR)
7.	EC-120B Colibri	3	Helo Trainer
8.	NAS-332 L1 Super Puma	3	Utility
9.	NBell-412 Bell	6	Helo Transport & SAR
10.	AS-565 MBe Panther	11	Helo Anti-Submarine Warfare (ASW)

Adapted from Hunter, J. (Ed.), "Jane's all the World's Aircraft—In Service 2014–2015," *HIS Global Limited*, 2014.

The Indonesian Armed Forces (Tentara Nasional Indonesia [TNI]) is seeking to set aside funds from the 2016 defense budget to procure four Boeing CH-47 Chinook heavy-lift helicopters for future procurement. This program has been confirmed by the TNI Commander and was announced in June 2015. Indonesia requires these Chinooks to boost the limited heavy-lift rotary-wing capabilities for their land and marine forces. The TNI has maintained this requirement to purchase the platform for several years, but budgetary constraints have precluded the purchase up to this point. The TNI's proposal to secure funding for the Chinook acquisition from the 2016 fiscal year defense budget is possible at the acquisition cost of approximately $30 million dollars per unit. If acquired, the Chinook will be utilized primarily in disaster-relief operations (Grevatt, 2015).

C. UNITED STATES MARINE CORPS

1. Marine Expeditionary Unit (MEU)

The Marine Air-Ground Task Force (MAGTF) serves as the USMC organizational base, providing structure for the Marine Corps mission execution throughout the entire range of military operations. The MAGTF will "consist of four core elements – a command element, a ground combat element (GCE), an aviation combat element (ACE), and a logistics combat element (LCE)" (MCDP 1-0, 2011, p. 2-6). A notional MEU or MEU Special Operations Capable organizational structure is shown in Table 8. This organization table shows a commander what forces are available. This structure is also capable of conducting disaggregated operations throughout a full range of military operations to include HA/DR (USMC, 2009).

Table 8. Notional MEU Structure and Organization

Element	COMMAND ELEMENT (CE)	GROUND COMBAT ELEMENT (GCE)	AVIATION COMBAT ELEMENT (ACE)	LOGISTICS COMBAT ELEMENT (LCE)	MARINE SPECIAL OPERATIONS COMPANY (MSOC)
	MEU/MEU (SOC) command and control is provided by the Command Element	The GCE is structured around a reinforced infantry battalion	The ACE is a composite/reinforced squadron structured around Medium Lift or Tilt-Rotor Squadron	The LCE is structured around Combat Logistic Battalion (CLB) provides the following	The MSOC is a special operations force partnered with the MEU/ARG for training and deployment
Personnel	Approximately 169 personnel: USMC: 25 OFF and 140 ENL, USN: 1 OFF and 3 ENL	Approximately 1200 personnel: USMC: 59 OFF and 1086 ENL, USN: 3 OFF and 50 ENL	Approximately 417 personnel: USMC: 75 OFF and 337 ENL, USN: 1 OFF and 4 ENL	Approximately 273 personnel: USMC: 14 OFF and 232 ENL, USN: 6 OFF and 21 ENL	Approximately 84 personnel: USMC: 8 OFF and 69 ENL, USN: 7 ENL
Comprised of	MEU/MEU (SOC) commander and staff	H&S Company	Medium Lift or Tilt-Rotor Squadron	Headquarters and Service Platoon	Company HQ
	Imagery Interpretation Det	Rifle Company x 3	Heavy Helicopter Squadron Det	Communications Platoon	Marine Special Operations Teams (MSOT) x 3
	Human Exploitation Team	Weapons Company	Light/Attack Helicopter Squadron Det	Maintenance Platoon	Enablers: Admin, EOD, Riggers, Maintenance, Supply, Ammo Techs, Fire Control Team, Embark
	Ground Sensor Det	Tank Platoon	Marine Attack Squadron Det	Supply Platoon	
	Topographic Det	Artillery Battery	Marine Fighter / Attack Squadron Det (Tethered)	Transportation Support Platoon (Includes Landing Support & Motor Transpotation)	
	Radio Battalion Det	LAR Platoon/Company	Marine Aerial Refueler / Transport Squadron Det	Health Services Platoon	
	Communications Battalion Det	Shore Fire Control Party	Marine Air Control Group Det	Engineer Platoon	
	Force Reconnaissance Platoon	Combat Engineer Platoon	Marine Wing Support Squadron Det		
	Military Police Squad	Division Reconnaissance Platoon	Marine Aviation Logistics Squadron Det		
		Assault Amphibian Vehicle Platoon			

Source United States Marine Corps (USMC), "Policy for Marine Expeditionary Units (MEU) and expeditionary units (special operations capable) MEU (SOC) (MCO 3120.9C)," 2009, http://www.marines.mil/News/Publications/ELECTRONICLIBRARY/ElectronicLibraryDisplay/tabid/13082/Article/126201/mco-31209c-final.aspx.

These components provide the Marine Corps a self-sufficient, sustainable means to project military power while maintaining a scalable expeditionary posture. MAGTFs are categorized into four type based on size and duration of self-sustainment. The Marine Expeditionary Force (MEF) is the largest and most complex type of MAGTF. It is comprised of over 40,000 personnel who can provide up to 60 days of internally supported operational combat capabilities, while the Marine Expeditionary Brigade (MEB) is structured to support over 16,000 personnel over a 30-day period (MCDP 1-0, 2011). The Marine Expeditionary Unit (MEU) is the smallest and most responsive type of MAGTF and normally consists of an infantry battalion combat logistics battalion and a composite Marine aircraft squadron. Its organic structure can provide up to 15 days of sustainment in austere conditions for approximately 2000 personnel (MCDP 1-0, 2011). Special Purpose MAGTF (SPMAGTF) is constructed to serve specific mission requirements and is tasked organized to augment the capabilities of existing expeditionary forces (MCDP 1-0, 2011).

The mission of a MEU is to "provide a forward deployed, flexible sea-based Marine Air Ground Task Force (MAGTF) capable of conducting Amphibious Operations, crisis response and limited contingency operations, to include enabling the introduction of follow on forces, and, designated special operations, in order to support the theater requirements of Geographic Combatant Commanders (GCC)" (USMC, 2009).

The MEU's core elements provide the flexibility required to support a variety of military operations. The organic equipment associated to each core component provides useful insight regarding supply capabilities as described in Table 9.

Table 9. MEU Baseline Equipment Requirements

CE	BLT	ACE	LCE	MSOC
(1) MEWSS LAV	(7) LAVs	(12) CH-46E/MV-22B	(2) TWPS	(16) HMMWVs
(18) HMMWVs	(15) AAVs/EFVs	(4) CH-53E	(5) Refuelers	(4) Trailers
(1) JTF Enabler	(4) Tanks ***	(4) AH-1W	(1) M88A1	
(6) CRRCs*	(6) M777A2	(3) UH-1N/Y	(15) MTVRs	
	(20) CRRCs**	(6) AV-8B	(18) HMMWVs	
	(2) ACEs	(5) A-MANPADS	(1) AAVR7	
	(16) MTVRs	(5) HMMWVs	(1) 5k Forklift	
	(8) 81 MMs	(2) KC-130	(1) EBFL Forklift	
	(8) TOW Launchers	(6) F/A-18 *****	(1) D-7	
	(64) HMMWVs		(1) Excavator	
	(7) IFAVs		(2) TRAM Forklift	
	(6) M327 (EFSS) ****			

Note	
CE	Command Element
BLT	Battalion Landing Team
ACE	Air Command Element
LCE	Logistics Combat Element
MSOC	Marine Special Operations Company
*	CONUS deploying MEUs embark (6) CRRCs.
**	31st MEU embark (20) CRRCs.
***	31st MEU does not embark.
****	The EFSS (120mm mortar) may be employed in place of the M777, in conjunction with the M777 (reduced numbers for both), or not at all.
*****	An F/A-18 Det could potentially be tethered to a MEU deployment.

Adapted from United States Marine Corps (USMC), "Policy for Marine Expeditionary Units (MEU) and expeditionary units (special operations capable) MEU (SOC) (MCO 3120.9C)," 2009, http://www.marines.mil/News/Publications/ELECTRONICLIBRARY/ElectronicLibraryDisplay/tabid/13082/Article/126201/mco-31209c-final.aspx.

2. The Maritime Pre-positioning Force (MPF)

The MPF is a strategically positioned material support asset that provides enough supplies and combat equipment to support a MEB for 30 days. Each MPF contains a maritime pre-positioning ships squadron (MPSRON), Navy support element and a MAGTF fly-in echelon (MCDP 1–0, 2011). MPSRON-3 is located in the Guam/Saipan area is capable of reaching the any point in Southeast-Asia within 3 days. MPF Enhancement (MPF-E) capabilities include a Navy Mobile Construction Battalion (NMCB) this provides engineering, and construction support, along with Expeditionary Medical Facilities (EMF) which supports level III medical care (HQMC, 2009). Collectively, these three components are capable of providing a large portion of the critical supplies and equipment during HA/DR operations.

D. USMC DISASTER RESPONSE

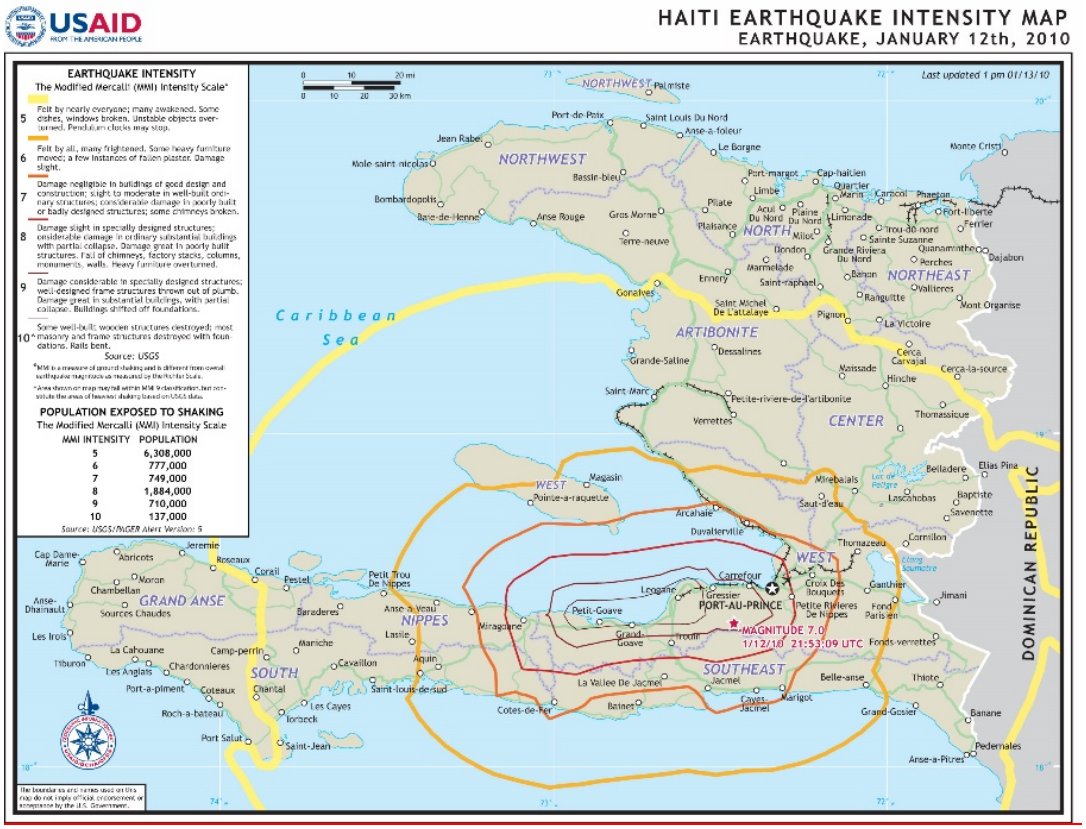
Each MEU is loaded to a baseline in accordance with the equipment and personnel designated in Tables 8 and 9. Even with this baseline, many external factors can influence the HA/DR response provided by the Marine Corps. In order to further understand the supply most likely provided by the USMC in a HA/DR scenario, we analyzed the USMC response to two recent disasters. The disasters chosen took place within the last five years, span developed and underdeveloped countries and involved a significant response from the Marine Corps MEU. A comparison between the 2010 Haiti Earthquake, 2011 Japan Earthquake and Tsunami and the 2015 Nepal Earthquake is shown in Table 10.

1. Operation Unified Response (2010 Haiti Earthquake)

On Tuesday, January 12, 2010, an earthquake registering magnitude 7.0 on the Richter scale struck approximately 15 miles WSW of Port-Au-Prince Haiti (USGS, 2010). The earthquake epicenter near Haiti's capital, the most populous portion of the island, is shown in Figure 8.

Already considered a fragile state due to years of political upheaval, military coups, and frequent natural disasters, the devastation caused by this earthquake was tremendous. According to 2013 RAND report titled *The U.S. Military Response to the 2010 Haiti Earthquake* over 316,000 people were killed, 300,000 injured and over 1,000,000 persons were displaced. In addition to this tremendous loss of human life, over 100,000 structures were destroyed with twice that number significantly damaged. Included in these numbers, the presidential palace and 14 of the 16 government ministry buildings were destroyed and many of the associated government officials working in these buildings were killed. All major sea and air ports were also incapacitated by the earthquake and would have to be reopened before any material or persons could flow in or out of the country (Cecchine et al., 2013).

Figure 8. Map of Haiti Earthquake Epicenter



Source United States Agency for International Development (USAID), "Haiti Earthquake Intensity Map," 2010, http://pdf.usaid.gov/pdf_docs/PNADR213.pdf.

Immediately following the earthquake, the President of Haiti sent a messenger to the U.S. ambassador requesting assistance. Built from this request, Operation Unified Response became the rest of the world's response to the disaster, including the United States of America "whole-government" response and the creation of Joint Task Force Haiti (JTF-Haiti). The Department of Defense assigned SOUTHCOM to be the lead element responsible for the coordination of HA/DR support. The 22nd and 24th MEUs were retasked in order to comprise the Marine Corps response elements. The mission of JTF-Haiti was stated as follows:

> JTF-Haiti conducts humanitarian assistance/foreign disaster response operations in support of USAID in Haiti to save lives, mitigate near-term human suffering and accelerate relief efforts to facilitate transition to GoH, UN, and USAID. (Cecchine et al., 2013, p. 32)

The first U.S. troops arrived in Haiti hours post-earthquake. U.S. Air Force Special Operations teams arrived and were tasked to reopen Toussaint Louverture International Airport (SOUTHCOM, 2010). The first Marine Corps units arrived in Haiti on January 18, with the USS Bataan Amphibious Group. This included members of the 22nd MEU and encompassed more than 2,200 Marines (Global Security, 2010). The intent of these troop deployments was to quickly stabilize the region and then turn the bulk of the HA/DR response back over to host government agencies, NGOs and the United Nations as quickly as possible. By the end of the response, the Marine Corps had deployed the 24th MEU embarked aboard the USS Nassau (LHA 4) Amphibious Ready Group, and the 22nd MEU embarked aboard the USS Bataan (LHD 5) Amphibious Ready Group (Margesson & Taft-Morales, 2010).

Operation Unified Response provided several challenges to the responding Marine Corps Units. In addition to the tremendous loss of life from the earthquake, severe damage was inflicted upon Haiti's infrastructure. According to a Post-Disaster Needs Assessment (PDNA) jointly published by the Government of Haiti and international partners, even before the earthquake there had been logistics transportation shortfalls. The PDNA stated, "with 3,400 km of roads, 800 km of them paved, the road network was very limited. The port and air infrastructures were in no position to act as a platform for economic growth" (Government of Haiti, 2010). The earthquake destroyed almost 8.75% of the paved roads, with much of this destruction on the heavily used routes between the ports and the capital city. The lack of trafficable roads led to issues with military vehicle movement and the reliance on helicopter transport.

The 22nd and 24th MEU assigned to support Operation Unified Response had vehicles that were capable of transporting necessary equipment and supplies over a broken or limited roadway. The Medium Tactical Vehicle Replacement (MTVR) is designed to traverse a 60% gradient and 30% side slope with its maximum cross-country load of up to seven tons of supplies (Oshkosh Defense, 2015). The two MEUs, with an augment from the MPF fleet, had just over 40 MTVRs available for use. Unfortunately, with the main roads severely damaged, the urban environment was too restrictive to utilize the MTVRs where they were most needed. Instead, the smaller High Mobility

Multi-Wheeled Vehicles (HMMWVs) were used—diminishing the per vehicle cargo capacity from 14,000 pounds to around five hundred pounds.

With diminished ground transportation availability, the MEU relied on airlift capability for many distribution and recovery operations. Unfortunately, the same tightly packed and poorly constructed buildings that limited the MTVR movements also diminished the number of available landing zones. LTG Keen, the Deputy Commander of U.S. Southern Command, said that "the use of helicopters in the congested areas where most of the Haitian people are in need, you're not going to be landing helicopters in those areas–we have to pick sites as close as we can" (Raddatz & Ayala, 2010). In addition to the inability to access the highly populated urban areas by air or ground, the temporary shelter facilities erected on the outskirts of the capital city also posed access issues. The rotor wash from the large cargo helicopters and tilt-rotor aircraft assigned to the MEU destroyed shelters and created hazardous flying debris. These concerns forced the relocation of the airborne deliveries to more remote landing zones and minimized the effectiveness of their use.

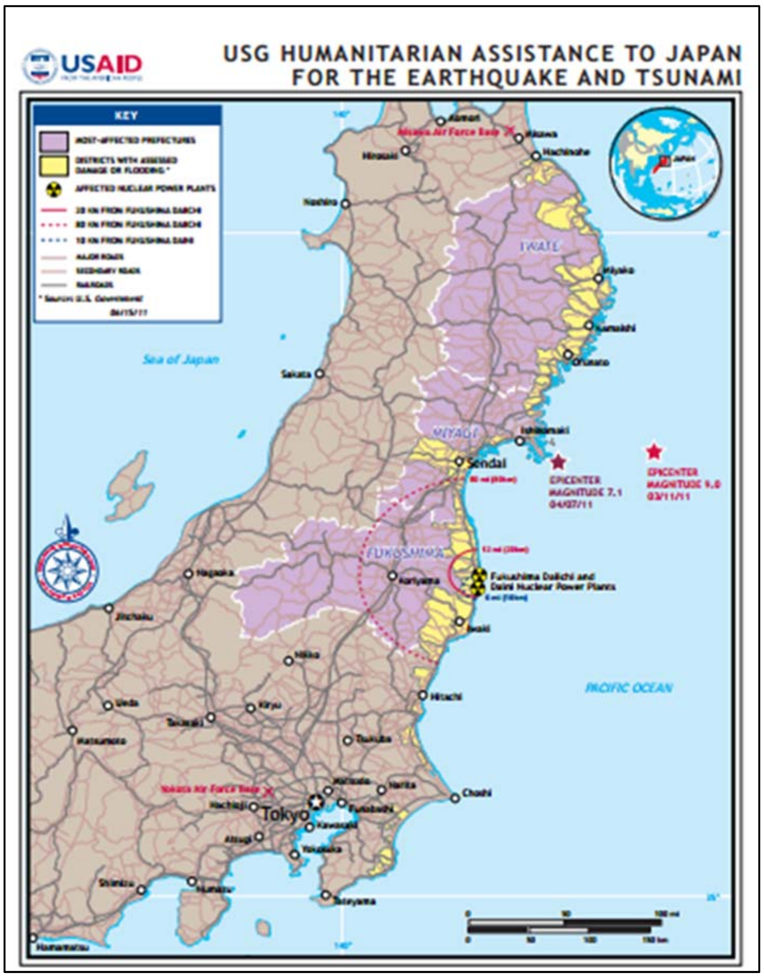
In total, more than 10,000 Sailors and Marines participated in Operation Unified Response. 17 ships, 48 helicopters and 12 fixed-wing aircraft were used to deliver relief supplies and to evacuate U.S. citizens and Haitians needing medical treatment (U.S. Navy, U.S. Fleet Forces Public Affairs, 2010). The 22nd MEU independently delivered:

- 560,000 liters of bottled water,
- 195,000 gallons of bulk water,
- 1.6 million pounds of rations,
- 15,000 pounds of medical supplies, and
- 618 flight missions flown to provide direct support to the Haitian people affected by the earthquake (USMC, 22nd MEU Public Affairs, 2010).

2. Operation Tomodachi (2011 Great East Japan Earthquake and Tsunami)

On Friday March 11, 2011, at 2:46 local time, a magnitude 9.0 earthquake struck off the East coast of Honshu, Japan (USGS, 2011). The earthquake caused widespread damage itself, while the tsunami it created had devastating onshore results due to the offshore earthquake epicenter and the narrow inlets leading to dense population centers. The epicenter of the earthquake and the widespread devastation caused by the earthquake, tsunami, and nuclear reactor fallout is shown in Figure 9.

Figure 9. Earthquake Epicenter in Japan



Source United States Agency for International Development (USAID), "USG Humanitarian Assistance to Japan for the Earthquake and Tsunami," 2011. http://pdf.usaid.gov/pdf_docs/pa00j43c.pdf.

Waves estimated to have reached over 35 meters caused the displacement of more than 470,000 people, the confirmed death of 15,889 people, injury of 6,152 more, and as of November 2014, 2,597 people remained officially missing (IFRC, 2015). In addition to the immediate loss of life and damage caused by the earthquake and tsunami, the Fukushima Daiichi Nuclear Power plant suffered a total loss of power to the active cooling systems. The damages led to several large explosions and the massive release of radioactive material—reaching a level 7 (the highest level) on the International Nuclear Event Scale (International Atomic Energy Agency, 2011).

In the immediate wake of the combined disasters, the Government of Japan (GoJ) requested HA/DR assistance from the United States. Operation Tomodachi (translated to "friend(s)" in Japanese) was the moniker given to the United States DOD response to the disasters. Immediately upon the receipt of the request for assistance, the USMC response began with surveillance provided by CH-46E helicopters from Marine Medium Helicopter Squadron 265, III MEF, as they traversed from Marine Corps Air Station Futenma to the U.S. Naval Air Facility Atsugi located on Honshu (Zielonka, Miller, & Walton, 2011).

Throughout Operation Tomodachi, the USMC involved over 3,600 Marines and Sailors in the repose effort. The preponderance of these members came from land bases on Okinawa and Mainland Japan, and from the 31st Marine Expeditionary Unit that had been conducting operations in Indonesia and Malaysia. Additional specialties to include Assessment and Consequence Teams (ACTs) and Chemical Biological Incident Response Forces (CBIRFs) were flown in from the United States (USMC, 2011b).

The scope of this disaster coupled with the long standing bilateral involvement with Japan made this a unique HA/DR response for the Marines. Located in the southern hemisphere when the Japanese earthquake struck, it took the 31st MEU just over 10 days to reform, reload and steam north to assist in the assistance operations. Upon their arrival, the MEU was utilized to reach outlying islands that had been cut off from their mainland sources of supply from the loss of bridges, pipelines and port infrastructure (Marine Corps Association and Foundation [MCAF], 2011). The primary sources of ship to shore transportation were the two Landing Craft Air-Cushioned and two Landing Craft

Utilities. Capable of hauling a combined tonnage of over 460 tons (170 tons per LCU and 60 tons per LCAC) (Global Security, 2011, 2012) per trip, the landing craft ferried medical supplies, potable water, food, comfort items, and military and Japanese civilian power generation equipment and mechanics to areas that had been unreachable until the MEUs arrival (MCAF, 2011).

The significant potential for radiation exposure throughout Operation Tomodachi brought a small but important military occupational specialty to the forefront of the HA/DR mission. The Chemical, Biological, Radiological, Nuclear (CBRN) Marines were utilized to monitor air, ground and water samples throughout the MEU response. The radiation threat also required that the CBRN Marines erected and manned decontamination sites in the event personnel or equipment were contaminated (USMC, 2011b).

3. Nepal Earthquake (2015)

During the process of conducting research for this project, a 7.8 magnitude earthquake struck central Nepal on April 25, 2015, causing widespread devastation (USGS, 2015). The location of this event (over 450 miles from the nearest coastline) made the USMC reaction much different from other cases that we studied. However, important lessons are being learned for USMC response in future HA/DR scenarios.

On May 3, 2015, the first USMC equipment and personnel to arrive in Nepal came in the form of tilt and rotor-wing aircraft to include (4) MV-22s and (3) UH-1N Hueys. The primary purpose of these assets was to assist in the delivery of critical aid items to civilians isolated by the earthquakes. Food, water and tarps designed for temporary shelters were the main items requiring transport (Marine Corps Times, 2015a). Tragically, on May 12, while delivering supplies, one Huey crashed and all six Marines and three additional persons onboard were killed in the accident (Marine Corps Times, 2015b).

4. USMC Disaster Supply Summary

Each disaster presents a wide-ranging set of problems, issues and potential solutions. A snapshot of the three disasters covered in the previous section is shown in Table 10 in order to highlight these variances.

Table 10. Disaster Comparison Tables—Haiti, Japan and Nepal

	Haiti Earthquake[1]	**Japan Earthquake and Tsunami**[2]	**Nepal Earthquake**[3]
Date	Tuesday, January 12, 2010	Friday, March 11, 2011	Saturday, April 25, 2015
Time	21:53:10 UTC / 04:53:10 PM Local	05:46:24 UTC / 02:46:24 PM Local	06:11:26 UTC / 11:56:26 AM Local
Location of Epicenter	25 km (15 miles) WSW of PORT-AU-PRINCE, Haiti	129 km (80 miles) E of Sendai, Honshu, Japan	77km (48 miles) NW of Kathmandu, Nepal
Earthquake Magnitude	7.0	9.0	7.8
Persons Killed	316,000	15,889	8,898
Persons Injured	300,000	6,152	22,309
Persons Missing		2,597	
Persons Displaced	1,000,000	470,000	2,800,000
Structures Destroyed	100,000	45,700	602,000
Structures Damaged	200,000	144,300	285,000

Adapted from:
1. Cecchine et al., "The U.S. Military response to the 2010 Haiti earthquake—Considerations for Army leaders," 2013, http://www.rand.org/RAND_RR304.pdf.; and then cross-referenced with_United Nations Office for the Coordination of Humanitarian Affairs (UNCHOA), "Nepal Earthquake," 2015, http://www.unocha.org/nepal.
2. IFRC, "Great East Japan Earthquake and Tsunami (GJET)," *4 year anniversary* [Facts and figures], 2015, http://www.jrc.or.jp/eq-japan2011/operations-update/pdf/Japan%20GEJET%204%20year%20facts%20and%20figures%28For%20HP%29.pdf.
3. Government of Nepal (GoN), "Nepal Disaster Risk Reduction Portal," June 21, 2015, http://drrportal.gov.np/.

In each of the MEU HA/DR responses that we researched, the initial readiness and availability of MEU equipment and personnel were similarly trained and prepared to support the HA/DR event. The differences in location, accessibility and post-disaster needs led to the distinct and diverse responses. Though the responses differed, a generalization can still be made regarding the response and capability potential that a MEU can provide during humanitarian assistance missions.

V. ANALYSIS

A. NOTIONAL SCENARIO

The 2006 Yogyakarta earthquake serves as our basis to analyze the response capability of the combined efforts between the USMC MEU and the Indonesian Navy. This event provides an ideal analytical source due to the high probability of reoccurrence of such an event in the South Pacific, and the extensive amount of demand data captured by response organizations. Our analysis of historical data revealed that the majority of seismic events recorded within our area of interest measure near 7.5 in magnitude (EM-DAT, 2012). The International Federation of Red Cross and Red Crescent Societies began recording personnel, logistic and material data for medial, sustenance and habitat demand requirements for the 24 hours after the onset of the earthquake. The lack of collected data pertaining to infrastructure and communication requirements promoted our group to express these requirements as capability thresholds instead of anticipated demand. The relative uniformity of data collected within these categories allowed us to identify initial critical needs throughout the various stages of response operations and created the scenario shown in Table 11.

B. CAPABILITIES

Our analysis of the Tentara Nasional Indonesia Angkatan Laut (TNI AL) and the Marine Expeditionary Unit (MEU) capabilities focus on Medical, Sustenance, Habitat and Infrastructure categories of demand. The basic method utilized to evaluate the capabilities of TNI AL and the USMC MEU through the comparison of the expected demand derived from the notional scenario compared to the potential supply is shown in Table 12. The remaining gap between supply and demand highlights areas that can be improved or expanded to tailor the capacity of the responding units.

Table 11. Notional Scenario Demand

Indonesian Navy regional response time:	0 hrs
USMC MEU regional response time:	~72 hrs
Earthquake Magnitude	7.5
Persons Killed	2500
Persons Injured	150,000 (22,000 critically)
Persons Missing	1,500
Persons Displaced	150,000
Critical Infrastructure Damage	20,000
Structures Damaged	80,000

The ideograms listed below serve as graphical representations of capability data related to Table 11, Notional Scenario Demand and in addition to Table 3, HA/DR Response Capability Matrix.

- Full Circle ● (Sufficient capability): Meets 80% of the expected demand for personnel, material, logistics support and communication needs during phases 1 and 2 of the depicted scenario.

- Half-filled Circle ◒ (Insufficient capability): Meets 40–79% of the expected demand for personnel, material, logistics support and communication needs during phases 1 and 2 of the depicted scenario.

- Empty Circle ○ (Capability nonexistent): Meets 39% or less of expected demand for personnel, material, logistics support and communication needs during phases 1 and 2 of the depicted scenario.

Table 12. Analysis of Capability Shortfall

Demand	Scenario Disaster
	Death/Injury/Displaced
	Infrastructure
Supply	Local Aid Organization
	TNI AL
	USMC MEU/ARG
	USMC Preposition
Δ	Demand Shortfall (Gap)

We will focus our analysis through the utilization of our capability matrix (shown in Table 3) and the categories of medical, sustenance, habitat and infrastructure. We will investigate the capabilities of the available personnel, material, logistics and communication assets that fall under each category. This analysis will produce a final matrix that can be used to develop remedial courses of action.

1. Medical

TNI AL has a hospital ship that would provide the initial response to the scenario disaster. This hospital ship has 16 physicians and 55 physician assistants and paramedics. This Indonesian hospital ship has 40 ward beds (Indonesian Navy, 2009), while TNI AL has the capacity to see approximately 570 patients per day (TNI Information Center, 2006, 2009). The MEU has two physicians, two physician assistants and 78 corpsmen (HQMC, 2015). These troops are organized into a Shock Trauma Platoon (STP) that is capable of conducting emergency treatment and triage. The remaining corpsmen are dispersed throughout the individual sub-units of the MEU and can provide localized treatment in the area affected by the disaster. The MEU also has the capacity to temporarily house 30 individuals in an evacuation ward while they await movement to a higher level of care on the ARG or at local medical facility. Afloat, the ARG has seven physicians and three dentists capable of providing critical emergency treatment and care for patients that have been evacuated from the shore to the ships of the ARG (HQMC, 2015). The MEU and the ARG are capable of treating up to 1,000 patients. TNI AL and the USMC MEU and ARG have a maximum capacity to treat 9,860 patients.

Table 13. Summary of Medical Capabilities

	TNI AL Hospital Ship[1]	USMC MEU[2]	USN ARG[2]	
Physician	16	2	7	
Dentist	0	0	3	
Physician Assistant	55	2	0	
Corpsmen	0	78	8	
Ward Beds	40	30*	730-800	
Patient Capacity/Day	570	100**	350	1020
				Total Capacity

* Temporary evacuation ward beds
** Maximum of 50 consultations per worker per day
Adapted from:
1. Indonesian Armed Forces (TNI) Information Center, 880 pasien korban gempa Padang dirawat di rumah sakit terapung KRI Dr. Suharso-990 (880 patients Padang earthquake victims hospitalized in the hospital ship KRI Dr. Suharso-990)," October 13, 2009, http://www.tni.mil.id/view-16035-880-pasien-korban-gempa-padang-dirawat-di-rumkit-terapung-kri-dr-suharso.html.
2. United States Marine Corps, Headquarters Marine Corps, "Amphibious Ready Group (ARG) and Marine Expeditionary Unit (MEU) Overview," 2015, http://www.hqmc.marines.mil/Portals/61/Docs/Amphibious_Capability.pdf.; and then cross-referenced with The Sphere Project, Humanitarian Charter and Minimum Standards in Humanitarian Response," 2011, http://www.ifrc.org/PageFiles/95530/The-Sphere-Project-Handbook-20111.pdf.

If a medical patient needs to be evacuated to a higher level of care, the Indonesian navy has three dedicated ambulances and one medical evacuation helicopter (TNI Information Center, 2006, 2009). The MEU has three dedicated HMMWV ambulances and 16 Medium and Heavy lift helicopters (MV-22 and CH-53) that can be utilized to transport medical patients to the ARG or to regional medical facilities as shown in Table 14 (Thirty-First Marine Expeditionary Group [31st MEU], 2005). Both the MV-22 and the CH-53 can lift 24 combat equipped Marines while the CH-53 can transport 55 civilians for medical evacuation or transportation (HQMC, 2015).

Table 14. TNI AL and MEU Medical Capacity

	MEDIVAC HELICOPTER	AMBULANCES
TNI AL	1[1]	3[2]
USMC MEU	16[3]	3[3]

Adapted from:
1. Indonesian Armed Forces (TNI) Information Center, "30 KRI dikerahkan ke Aceh (30 Indonesian navy warships deployed to Aceh)," February 22, 2005e, http://tni.mil.id/view-814-kri-teluk-ratai-angkut-bantuan-ke-aceh.html.
2. Indonesian Armed Forces (TNI) Information Center, "6,173 personnel TNI dikerahkan ke Aceh (6,173 naval personnel deployed to Aceh), "February 2, 2005d, http://tni.mil.id/view-754-6173-personel-tni-dikerahkan-ke-aceh.html.
3. United States Marine Corps, Headquarters Marine Corps, "Amphibious Ready Group (ARG) and Marine Expeditionary Unit (MEU) overview," 2015, http://www.hqmc.marines.mil/Portals/61/Docs/Amphibious_Capability.pdf.

2. Sustenance

Beyond the immediate need of medical services and support, the requirement for basic sustenance can quickly become an emergency request in a HA/DR situation. The Indonesian Navy can provide field mess feeding for up to 10,000 evacuees per day for two meals. In addition to these people receiving food, TNI AL has 4,500 Meals-Ready-to-EAT (MREs), 120 tons of rice, and 25,233 gallons of bottled water that can be distributed for those that cannot be served at the field mess (TNI Information Center 2005b). The MEU has 45,000 MREs available, can provide field mess feeding for up to 4,500 people per day (two meals per day) and can produce 24,000 gallons of potable water ashore. The ARG can augment this potable water production and can produce 332,000 gallons of purified water at sea (HQMC, 2015). The Organization for Economic Coordination and Development (OECD) published consumption requirement for basic survival needs in their Guidance for the Evaluation of Humanitarian Assistance in Complex Emergencies. They proposed a range of 7.5–15 liters (2–4 gallons) of water to be required per day, per person (OECD, 1999). For this analysis we have averaged this range of numbers to requirements for three gallons of potable water and two meals per day. The figures and provisions provided by TNI AL and the MEU during both surge and sustainment relief operations are described in Tables 15 and 16.

Table 15. TNI AL and MEU Sustenance Capacities (by Type Available)*

	Bottled Water		Purified Water		MREs		Field Mess	
	TNI AL[1]	MEU/ARG[2]	TNI AL[1]	MEU/ARG[2]	TNI AL[1]	MEU/ARG[2]	TNI AL[1]	MEU/ARG[2]
Available	25,233	0	0	356,000	4,500	45,000	20,000	9,000
Required/Day/ Person	3	3	3	3	2	2	2	2
Total People (Surge)	8,411	0	0	118,666.7	2,250	22,500	10,000	4,500
Total People (Sustained)				118,666.7			10,000	4,500

* All water quantities are given in gallons and food requirements are MRE individual units and in persons fed per day for Field Mess feeding.
Adapted from:
1. Indonesian Armed Forces (TNI) Information Center, "Jajaran TNI AL bantu Aceh secara total (TNI AL helped Aceh totally)," January 20, 2005b, http://www.tni.mil.id/ view-738-pangarmabar-jajaran-tni-al-bantu-aceh-secara-total.html.
2. United States Marine Corps, Headquarters Marine Corps, "Amphibious Ready Group (ARG) and Marine Expeditionary Unit (MEU) Overview," 2015, http://www.hqmc.marines.mil/Portals/61/Docs/Amphibious_Capability.pdf.

Table 16. TNI AL and MEU Sustenance (Surge and Sustained Capacities*

Water (Surge)	127,078
Food (Surge)	39,250
Water (Sustained)	118,667
Food (Sustained)	14,500

* All water quantities are given in gallons and food requirements are given in persons fed per day. Adapted from United States Marine Corps, Headquarters Marine Corps, "Amphibious Ready Group (ARG) and Marine Expeditionary Unit (MEU) Overview," 2015, http://www.hqmc.marines.mil/Portals/61/Docs/Amphibious_Capability.pdf, and Indonesian Armed Forces (TNI) Information Center, "Jajaran TNI AL bantu Aceh secara total (TNI AL helped Aceh totally)," January 20, 2005b, http://www.tni.mil.id/view-738-pangarmabar-jajaran-tni-al-bantu-aceh-secara-total.html.

3. Habitat

With the frequency of large-scale disasters taking place in Indonesia, local aid organizations have prepositioned nearly 12,000 shelters capable of housing up to 60,000 displaced people (TNI Information Center, 2005e). The Indonesian Navy has 40 field tents and 1,000 family tents embarked upon the responding LPD. Each field tent can house 45 people while the family tents can hold 5 people. The total shelter provided by TNI AL is approximately 6,800 people (TNI Information Center, 2005e). The MEU carries 25 General Purpose (GP) tents which can house up to 20 people (Tentnet.org, 2015). This gives the MEU the ability to provide shelter to approximately 525 people (31st MEU, 2005). Taken as a total, approximately 67,325 people can be provided shelter with the given stock levels is shown in Table 17.

Table 17. TNI AL and MEU Shelter Capacity

	Number of Personnel Sheltered
NGO	60,000
TNI AL[1]	6800
USMC MEU[2]	525
Total	67,325

Adapted from:
1. Indonesian Armed Forces (TNI) Information Center, "30 KRI dikerahkan ke Aceh (30 Indonesian navy warships deployed to Aceh)," February 22, 2015, http://tni.mil.id/view-814-kri-teluk-ratai-angkut-bantuan-ke-aceh.html.
2. Thirty-First Marine Expeditionary Group (31ST MEU) and Commander Amphibious Squadron 11 (CPR 11) briefing, "31ST MEU / CPR 11 Humanitarian Assistance Disaster Relief Capabilities," 2005, http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB4QFjAAahUKEwj7m4LdpZrHAhVRlIgKHeV0C2Y&url=http%3A%2F%2Fwww.hqmc.marines.mil%2FPortals%2F138%2FDocs%2FPL%2FPLU%2FHADR%2520Capabilities%2520Brief%2520v3.pptx&ei=cWLGVbufH9GoogTl6a2wBg&usg=AFQjCNFGmkFUBqlkgwAOUyP5LC1HtF6CWg&bvm=bv.99804247,d.cGU.

4. Infrastructure

We were unable to find suitable data to conduct an analysis for the potential damage to infrastructure and the ability for repair. The dynamic response environment and unknown outcome of any given HA/DR scenario precluded our ability to pinpoint a daily consumption rate of material or the vehicle and personnel requirements. Infrastructure repair is an important function in HA/DR response and can assist in the distribution of critical supplies. Both TNI AL and the MEU have limited capabilities to conduct these operations. According to the TNI Information Center (2005c, 2005d), unless otherwise noted, the equipment from the Indonesian Navy includes:

- 2 Excavators (24 tons each)
- 1 Road Grader (14 tons)
- 1 Crane Truck (between 25 and 60 tons)
- 1 Front-End Loader
- 1 Bulldozer

- 1 Dump Truck (M. Isarisnawan, personal communication, August 14, 2015)[2]
- 8,000 45kg sacks of cement
- 223 m^3 of wood, and
- 500 pieces of zinc roofing (TNI Information Center, 2005c, 2005d)

The USMC MEU has the following equipment that can be utilized for infrastructure development and repair:

- 3 Bulldozers
- 1 Excavator
- 3 Forklifts (HQMC, 2015)

Additionally, the MEU CLB engineering platoon can provide the following:

- Mobile power generation
- Village water cistern reinforcement
- Limited vertical building
- Roof replacement, and
- Debris removal (HQMC, 2015)

5. Logistics

The Marine Corps recognizes six separate functions of logistics to include Supply, Maintenance, Transportation, General Engineering, Health Services and General Services (MCWP 4-11, 2000). With Health Services representing a large portion of HA/DR response, this section has been broken out of the logistics section and given its own category for this analysis. Additionally, many logistics functions overlap with the sustenance category. This section will identify the remaining logistics material utilized by TNI AL and the USMC MEU in support of HA/DR operations.

[2] This information was conveyed to the authors through voice and electronic communication during our research, summer quarter, Naval Postgraduate School.

TNI AL primarily conducts its own organic logistics, and has the following equipment available for utilization in HA/DR scenarios:

- 2 LCUs
- 14 Trucks (eight ton max load per truck, 112 ton total hauling capacity)
- 1 firefighting vehicle (5,000 liters of water) (TNI Commander Regulations, 2007)

The MEU has the Logistics Combat Element (LCE) comprised of around 273 Marines and Sailors assigned to the Combat Logistics Battalion (CLB) (HQMC, 2015). The CLB is subdivided into Headquarters Platoon, Law Enforcement Detachment, Maintenance Detachment, Medical Detachment, Engineer Platoon, Communications Platoon, and Explosive Ordinance Disposal (EOD) Detachment, Supply Detachment and Landing Support Platoon (HQMC, 2015). These sections provide the bulk of the logistics power of the MEU and can be augmented from the Ground Combat Element or Air Combat Element of the MEU to support HA/DR operations. The USMC states that a MEU and associated ARG can provide the following logistics equipment:

- 4–7 LCAC and LCUs
- 46 MTVR (seven ton hauling capacity per truck, 322 ton total hauling capacity)
- 123 HMMWVs
- 2 Wreckers
- 3 bulldozers
- 3 forklifts
- 4 bulk fuel trucks (5,000 gal of fuel on each truck for a total of 20,000 gal of fuel)
- 2 water trucks (1,800 gal of water per truck for a total of 3,600 gal of water)
- 2–5 water purification systems (advertised water production of 24,000 gal/day)
- 5,400 gal mobile–distribution/storage

- 30,000 gal static–storage
- 1 tank recovery asset
- 1 recovery AAV
- 2 Non-Combatant Evacuation Operation (NEO) Tracking Systems (NTS) (HQMC, 2015)

Additionally, the Air Combat Element of the MEU can utilize their 16 medium and heavy lift helicopters/tilt-rotor (12 x MV-22, 4 x CH-53) to move logistics supplies throughout the affected area.

6. Communication

Similar to the logistics assets of TNI AL and the MEU, communication assets of the HA/DR responders from the Indonesian Navy and USMC MEU are utilized throughout the spectrum of operations. The same equipment is utilized to gain and maintain connectivity in each of the support categories to include Medical, Sustenance, Habitat and Infrastructure. TNI AL has several long range communication assets that can be deployed throughout a disaster area. The headquarters element utilizes their Very Small Aperture Satellite (VSAT) and Broad Global Area Network satellite terminals (BGAN) to create a central communications hub. Single Side Band (SSB) radio multiband units, repeater links, global positioning systems, and handheld individual radios are utilized by smaller units to the main TNI AL communications hub (BNPB, 2010). The key takeaway from the MEU communication architecture is that once the MEU has disembarked the ARG, they are capable of conducting Command and Control Operations through two separate and potentially disaggregated locations. The two Command and Control Operations Centers (COCs) are connected to the remainder of the MEU and the ARG with multiple Very High Frequency (VHF), High Frequency (HF) and Ultra-High Frequency (UHF) Satellite Communication links for voice and limited data communication. The COCs also have a Non-Secure Internet Protocol Router network (NIPR), and a Secure Internet Protocol Router Network (SIPR) for unclassified and classified Internet access provided through the utilization of a BGAN. Once the COCs are established, the portions of the MEU working throughout the affected region can remain in constant communication via their organic Mobile Radio Communication (MRC) vehicles, installed Blue-Force Tracker (BFT) devices, man packable VHF, UHF and Satellite Communication radios and hand held Iridium Satellite Phones (HQMC, 2015).

The following is a sample of what the 31st MEU advertised as their communication asset availability for HA/DR response:

- 10 x Mobile Radio Communication (MRC-148) Vehicles with Very High Frequency (VHF), High Frequency (HF) and Satellite Communication (SATCOM) (voice and data) support ashore
- Two COCs with full spectrum of core services to include NIPR, SIPR, and Data Source Name (DSN) phone service
- 16 x MRC-145 Vehicles with VHF, HF and SATCOM ashore
- 3 x BGAN for mobile broadband NIPR, and
- Mobile voice communication VIA UHF SATCOM and Iridium SatPhone (31st MEU, 2005)

C. CAPABILITY SHORTFALLS

We identified HA/DR capabilities gaps by examining the total requirements developed from the notional scenario outline in section 5A in order to define the appropriate response of the Indonesian Navy and the USMC MEU. We applied the demand information from this scenario in the support categories developed in Table 15 to include Medical, Sustenance, Habitat and Infrastructure. The capabilities of the Indonesian Navy were then applied to this demand, creating a final gap into which we leveraged the capabilities of the USMC MEU and in some cases the associated ARG.

Utilizing the notional scenario as a representation of supply and the capabilities of TNI AL and MEU/ARG as the demand, we developed a response matrix shown in Table 18.

Table 18. TNI AL and MEU Response Capability Matrix

	Personnel		**Material**		**Logistics**		**Communication**	
	MEU	TNI	MEU	TNI	MEU	TNI	MEU	TNI
Medical	◒	◒	●	◒	●	◒	◒	◒
Sustenance	◒	◒	◒	◒	◒	◒	◒	◒
Habitat	◒	◒	◒	◒	●	◒	◒	◒
Infrastructure	◒	◒	○	◒	●	◒	◒	◒

○ No Capability ◒ Insufficient Capability ● Sufficient Capability

Based on the capability data we find that there are several gaps and shortfalls. Gaps are depicted by an empty circle, which represents the absence of a critical capability from both the Indonesian Navy and the United States Marine Corps. Shortfalls are represented by a partially shaded circle and denote a critical capability that provides an insufficient amount of support to meet baseline scenario requirements. Completely shaded circles indicate sufficient capabilities in marked categories. With this analysis we found zero gaps, fourteen categories that are considered insufficient, and two categories that are sufficient.

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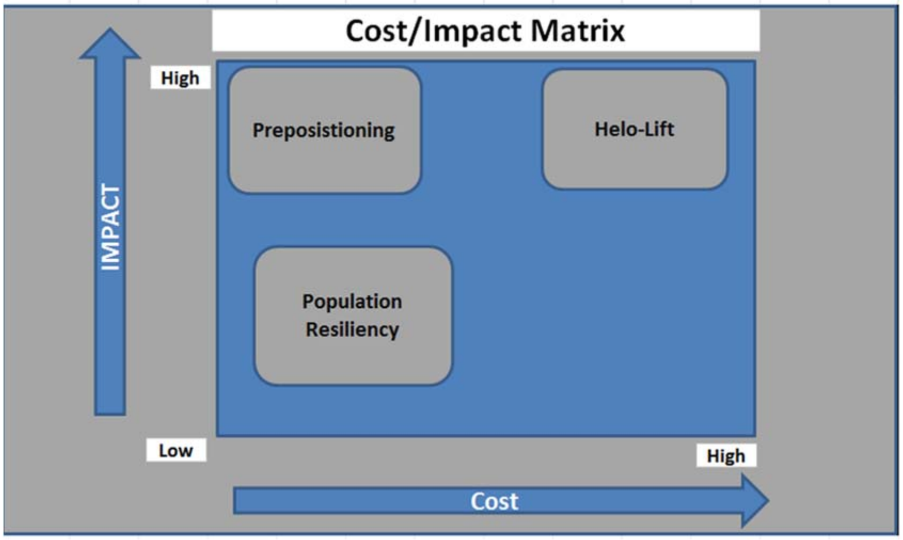
VI. CONCLUSION

A. PROPOSED COURSES OF ACTION

We quantified the impact of the USMC MEU and Indonesian naval assets by basing demand priority on the resources that have the greatest effect in the preservation of human lives. The shortfalls and potential gaps observed in the previous section lead us to possible remedies for mitigating identified gaps between the potential demand and available supply in an Indonesian HA/DR scenario. To address these shortfalls we have identified three areas for increasing response capability in order to decrease the negative impacts of a disaster. Our research ranks the delivery of medical assistance and sustenance as the two most important contributors providing critical support to large effected populations. The communication and logistical support required for the expedient distribution of these two elements serves as the greatest challenge during HA/DR response operations and represent the most significant recommended courses of action. These include the procurement of additional vertical lift assets by the Indonesian Navy, the pre-positioning of critical relief supplies, and the proactive measure of building population resiliency through continued disaster education and training. In Figure 10, we utilized a cost impact matrix to depict the relationship between potential benefits derived from implemented improvements against the associated cost to acquire this improvement.

Figure 10. HA/DR COA Cost/Impact Matrix



1. Increasing the Capacity of Indonesian Vertical Lift Assets (High Cost/Major Impact)

Vertical lift assets provide the greatest impact in reaching remote or isolated population centers and in the evacuation of critically injured personnel. Vertical lift also requires the largest capital contribution to obtain and maintain the capability. The acquisition of additional vertical lift assets by the Indonesian Navy would directly impact their logistics and communication capabilities presented in Table 19.

Table 19. Impact of Vertical Lift Acquisition by TNI AL

	Personnel		Material		Logistics		Communication	
	MEU	TNI	MEU	TNI	MEU	TNI	MEU	TNI
Medical	◒	◒	●	◒	●	◒	◒	◒
Sustenance	◒	◒	◒	◒	◒	◒	◒	◒
Habitat	◒	◒	◒	◒	●	◒	◒	◒
Infrastructure	◒	◒	○	◒	●	◒	◒	◒

Inadequate transportation infrastructure, sporadic population dispersion, and challenging terrain are the core elements that drive the vertical lift requirement. Rotary winged aircraft serve as versatile platforms to provide logistical support for the entire spectrum of HA/DR demand. These assets transport medical supplies, personnel and equipment to remote regions without runways or prepared landing zones. The MEU's combined vertical lift assets can transport a total of 260,000 pounds (160 pallets) of material or 1500 passengers per day. This equates to over 90,000 MREs or 30,000 gallons of water per day, which can deliver 100 percent of food surge capacity or 25% of total water surge capacity. If the Indonesian Navy is successful in the acquisition of Chinook medium-lift helicopters their ability to distribute needed supplies will increase while their reliance on external military or civilian helicopters will decrease.

2. Pre-positioning Critical Material

Pre-positioning supplies also provides a major impact in the preservation of lives during the first phases of a disaster. This provides the ability to quickly receive and distribute food, water, shelter, and medicine to the affected population. Additionally, the availability of these critical supplies in an accessible location will reduce the strain on the overall supply chain as additional items are surged to the disaster site. The highlighted categories in Table 20 show the potential gains resulting from a tailored pre-positioning program.

Table 20. Impact of Regional Pre-positioning on HA/DR Capabilities

	Personnel		Material		Logistics		Communication	
	MEU	TNI	MEU	TNI	MEU	TNI	MEU	TNI
Medical	◒	◒	●	◒	●	◒	◒	◒
Sustenance	◒	◒	◒	◒	◒	◒	◒	◒
Habitat	◒	◒	◒	◒	●	◒	◒	◒
Infrastructure	◒	◒	○	◒	●	◒	◒	◒

Two of the primary categories that require pre-positioning are sustenance and habitat. In the right conditions, both of these items can be stored for extended periods of time and require less preventative maintenance than mechanical equipment.

Dehydration is the second leading cause of death during a nature disaster. Humans require an average of 2–4 gallons of potable water per day for consumption, hygiene and basic cooking needs (Sphere, 2011). Bottled water or water purification (mechanical or chemical) are both options for pre-positioning, but will require vastly different storage and life cycle costs. Prolonged exposure to the harsh tropical climate of the South-Pacific is another leading cause of human suffering during a natural disaster. The acquisition of additional shelter units will provide needed relief from the elements for the affected population. Tent and tarpaulins are an effective option that is easy to store, transport and construct.

Supply pre-positioning has been conducted by the Marine Corps with both afloat prepositioned ships and at fixed locations in the United States and other strategic locations to include Norway. The Marine Corps Pre-positioning Program—Norway (MCPP-N) is an example of USMC equipment staged in a strategic location to help counter a potentially aggressive enemy force. Key tenets to the Norwegian-based prepositioned stockpiles include:

- The Norwegians bear a large portion of the financial burden for the storage, maintenance and system upgrades that take place on the prepositioned equipment (HQMC, 2009). The Memorandum of Understanding between the United States and Norway states that "the Government of the Kingdom of Norway contribution will be limited to half of the total costs incurred or the ceiling set in U.S. dollars to be negotiated by the Parties, whichever is less" (Department of State, 2005).
- The prepositioned locations are secure. This includes both a secure storage location (underground caves) and a stable political environment.
- Joint exercises (Exercise COLD RESPONSE) are conducted to develop and refine standard operating procedures (SOPs) while establishing working relationships between Norwegian and Marine Corps forces.
- The Government of the Kingdom of Norway (GoKoN) provides the personnel, equipment and infrastructure to support the Reception, Staging, Onward Movement and Integration (RSO&I) of the prepositioned equipment (HQMC, 2009).

We propose a similar prepositioned model in Southeast Asia. Instead of stockpiling equipment needed to fight an enemy, material utilized for HA/DR scenarios would be stored in a static location. An agreement of this nature could effectively stage needed material while continuing to strengthen political and economic ties between the United States and South Pacific nations.

3. Increasing Population Resiliency

Early detection and response to slow onset disasters such as tsunamis can also have a substantial impact on the subsequent demand for HA/DR related assistance. The United Nations for International Strategy for Disaster Reduction (UNISDR), defines a disaster-resilient community as a society which is capability of preventing, confronting, and recovering from disaster threats in a timely manner (Valency & Lazarte, 2007). This definition can include many widely varied projects. Examples that have been implemented include the development of low cost solutions to strengthen and renovate homes in typhoon prone areas and the augmentation modern scientific instrumentation with local historical knowledge to build early warning systems (Valency & Lazarte, 2007). Solidarity and mutual relationships within resilient communities can encourage the implementation of these resiliency programs, giving priority to the common good. Categories in which an increase in population resiliency can potentially decrease the dependence on outside assistance during the initial disaster response phases is shown in Table 21.

Table 21. Impact of Population Resiliency Programs on HA/DR Capacities

	Personnel		Material		Logistics		Communication	
	MEU	TNI	MEU	TNI	MEU	TNI	MEU	TNI
Medical	◒	◒	●	◒	●	◒	◒	◒
Sustenance	◒	◒	◒	◒	◒	◒	◒	◒
Habitat	◒	◒	◒	◒	●	◒	◒	◒
Infrastructure	◒	◒	○	◒	●	◒	◒	◒

Building resiliency is one of the lowest cost options to provide a measurable impact to disaster affected communities, but it must be implemented and fully engrained within a group prior to the strike of a disaster. Because of the pre-disaster requirements of resiliency, existing programs need to be evaluated for effectiveness, reworked or created where needed to cover probably future scenarios and expanded to reach the most isolated communities. This will include a unified effort from the host country and partnered aid organizations.

B. ADDITIONAL RESEARCH OPPORTUNITIES

Throughout the conduct of this project, additional research opportunities were identified. This related research would build upon this work and provide supplementary knowledge for HA/DR responders and response organizations. This research would not be limited too, but could include the following:

1. Develop a model to determine the most suitable location for future pre-positioning sites in the vicinity of Indonesia or its ASEAN partners.

2. Cost benefit analysis comparing the pre-positioning of critical material against the immediate acquisition and transportation of the same types of material post-disaster.

3. Analyze applicable costs (to both the USMC and Norwegian Military) associated with the prepositioned stockpiles in Norway in order to apply a similar model towards HA/DR stockpiles in the South Pacific.

4. Develop future joint exercises between the MEU and Indonesian naval counterparts to further enhance coordination between the two forces for HA/DR response.

5. Cost analysis for the acquisition and maintenance costs associated with the procurement of Chinook rotary-wing assets by the Indonesia Ministry of Defense for the Indonesian Navy.

6. Conduct an inclusive analysis of regionally effective NGOs to ascertain a potential level of post-disaster supply.

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