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Cost analysis of U.S. Navy Humanitarian Assistance and Disaster Relief missions

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NAVAL POSTGRADUATE SCHOOL

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MBA PROFESSIONAL REPORT

COST ANALYSIS OF U.S. NAVY HUMANITARIAN ASSISTANCE AND DISASTER RELIEF MISSIONS

December 2014

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In the wake of rising costs and limited budgets, the U.S. Navy has been challenged to perform its missions while pursuing opportunities to reduce operating costs. One of those missions that has expanded recently is Humanitarian Assistance and Disaster Relief (HA/DR). In 2007, the Navy officially added Humanitarian Assistance and Disaster Relief as a core competency to its maritime strategy. From 1970 to 2000, the Navy diverted vessels 366 times for HA/DR operations, as opposed to 22 times for combat operations. With the ever-expanding role of the U.S. Navy in HA/DR operations, it is important to study how the Navy can perform its missions while saving costs. This report serves to provide Navy leadership with policy recommendations that will improve HA/DR mission capabiility while saving costs at the same time.

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COST ANALYSIS OF U.S. NAVY HUMANITARIAN ASSISTANCE AND DISASTER RELIEF MISSIONS

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Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

In the wake of rising costs and limited budgets, the U.S. Navy has been challenged to perform its missions while pursuing opportunities to reduce operating costs. One of those missions that has expanded recently is Humanitarian Assistance and Disaster Relief (HA/DR). In 2007, the Navy officially added Humanitarian Assistance and Disaster Relief as a core competency to its maritime strategy. From 1970 to 2000, the Navy diverted vessels 366 times for HA/DR operations, as opposed to 22 times for combat operations. With the ever-expanding role of the U.S. Navy in HA/DR operations, it is important to study how the Navy can perform its missions while saving costs. This report serves to provide Navy leadership with policy recommendations that will improve HA/DR mission capabiility while saving costs at the same time.

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TABLE OF CONTENTS

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LIST OF FIGURES

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LIST OF TABLES

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LIST OF ACRONYMS AND ABBREVIATIONS

C2	Command and Control
CG	Guided Missile Cruiser
CRED	Centre for Research on the Epidemiology of Disasters
CS21	Cooperative Strategy for the 21st Century
CVN	Aircraft Carrier Vessel, Nuclear
DoD	Department of Defense
DDG	Guided Missile Destroyer
DR	Disaster Relief
EM-DAT	Emergency Events Database
FEMA	Federal Emergency Management Agency
FFG	Guided Missile Frigate
HA	Humanitarian Assistance
HA/DR	Humanitarian Assistance/Disaster Relief
HSV	High Speed Vessel
LHA	Landing Helicopter Assault, a multi-purpose assault ship
LHD	Landing Helicopter Dock, a multi-purpose assault ship
LSD	Landing Ship Dock, an assault ship
NMS	National Military Strategy
PACOM	Pacific Command
QDR	Quadrennial Defense Review
SSN	Attack Submarine, Nuclear Propulsion
SWO	Surface Warfare Officer
T-ACS	Tactical Auxiliary Crane Ship
T-AFS	Tactical Active Fleet Ship
T-AGS	Tactical Oceanographic Survey Ship
T-AH	Tactical Hospital Ship
T-AK	Tactical Container Ship
T-AKE	Tactical Dry Cargo Ship
T-AKR	Tactical Vehicle Cargo Ship
T-AO	Tactical Replenishment Oiler

T-AOE	Tactical Fast Combat Logistics Oiler
T-ARS	Tactical Salvage Ship
VAMOSC	Visibility and Management of Operating and Support Costs

ACKNOWLEDGMENTS

On December 27, 2004, I was a helicopter pilot stationed on board the U.S.S ABRAHAM LINCOLN. The carrier battle group had jU.S.t pulled out of Hong Kong for a port visit and we were supposed to be heading north in order to patrol the waters off the Korean shores. Instead, we were heading south. Then Rear Admiral Douglas Crowder, the Battle Group Commander, made the decision to head toward the area where a tsunami had struck just the day before. I had heard vague descriptions of the disaster, but just days later, we were in position to help the stricken survivors. Over the course of the next month, I delivered over 100,000 pounds of food, water, and medical supplies, provided valuable reconnaissance information from my position in the air, and rescued 93 survivors from their plight. It was the most rewarding mission of my life and helped sway my decision to stay in the Navy years later.

In 2012, I had a discussion about HA/DR with a colleague who is a Surface Warfare Officer, who had quite a different experience on board a guided missile destroyer the Navy sent in response to the earthquake in Pakistan. The Navy had diverted his ship approximately 1200 miles in order to respond to the crisis and when the ship arrived, it was only able to offer minimal support. While they could act as a refueling station for helicopters operating in the area, the ship could not provide any direct support to the devastated area as they did not have a helicopter stationed onboard. My friend was extremely frustrated as they had been performing an important mission before responding to the earthquake and believed that his ship was actually a hindrance to the relief effort because his ship was clogging the area without being able to provide support.

Ever since I had that conversation with my friend, I had always felt empathy for his situation. Now that I've been studying finance at the Naval Postgraduate School, I have a new perspective on his circumstances: what a waste of taxpayer dollars! It was with this thought in mind that inspired me to write this report.

I would like to thank the Visibility and Management of Operating and Support Costs Center for their help in providing such valuable data to complete this project. I would also like to thank Professors Aruna Apte and Keenan Yoho for their guidance and support throughout the duration of this project.

I. INTRODUCTION

A. BACKGROUND

In December 2004, a Tsunami devastated hundreds of miles of the Sumatran coastline. Because the Tsunami was sudden in onset and dispersed across a large geographic area (Apte, 2009), the Indonesian infrastructure had a difficult time providing basic supplies to the ruined villages (Ures, 2011). At the time, the *U.S.S ABRAHAM LINCOLN* Carrier Strike Group was just leaving a port-call in Hong Kong when news arrived of the calamity. The commander made the decision to move his ships towards the destruction instead of going north to patrol the North Korean coastline, and proceeded to demonstrate the U.S. Navy's unique and valuable capabilities in the wake of disasters with its highly successful response to this crisis.

Since that disaster, the U.S. Navy has successfully responded to the 2010 Haiti earthquake and the 2011earthquake in Tohoku, Japan, but there was very little thought about the financial implications of each operation. Given the high visibility of these types of missions, "send everything and we'll figure out how to pay for it later" is a forgivable strategy. While the Navy has done much to improve its ability to respond to disasters, it has done very little to consider costs in its mission. Instead, the Navy has sent practically every available asset at its disposal. This project will provide information to Navy leadership about what assets should be sent in response to these types of crises in order to provide the most capability and minimize costs at the same time.

This project will analyze the costs associated with those three major operations in order to provide senior leaders with information of what the best options are in future disasters. The project specifically attempts to determine a "capability score" for every platform the U.S. Navy and the Military Sealift Command sent during each of those crises. The report will then derive data from the Navy Visibility and Management of Operating and Support Costs website to determine the actual costs of sending each ship to respond to the three disasters and compare those costs to the capability score.

Graphical representation of the comparison can lead to further analysis and show which ships are the most cost effective for a given level of HA/DR response capability. The goal of this project is to offer Navy leadership an analytical framework and set of policy recommendations that show which ships are likely to provide the most capability during a HA/DR operation at the lowest possible cost.

B. SUMMARY OF METHODOLOGY

Using the Visibility and Management of Operating and Support Costs Database, which contains historical reports of the actual costs to operate every ship in the U.S. Navy and the Military Sealift Command annual costs were gathered for every ship sent in relief for three different operations: Indonesia in 2005, Haiti in 2010, and Japan in 2011. I divided those costs by 365 in order to determine a daily operating cost for each ship. I then separated the ships by type and normalized the costs to fiscal year 2015 dollars using the appropriate inflation index in order to establish a daily operating cost by ship type.

The next step was to determine a capability score for each ship. Based on Greenfield and Ingram (2011); Kaczur, Aurelio, and Joloya (2012); Apte, Yoho, Greenfield, and Ingram (2013); and my own expertize in the subject matter I assigned a point system for each of the following capabilities:

- Helicopters aboard,
- Aircraft support,
- Landing craft support,
- Search and rescue support,
- Dry goods,
- Refrigerated goods,
- Fresh water,
- Roll on/roll off,

- Fuel,
- Self-sufficiency,
- Personnel transfer,
- Freshwater production,
- Personnel support,
- Berthing capacity,
- Medical support,
- Transit speed,
- Hydrographic survey,
- Salvage operations, and
- Towing.

After assigning a value to the categories, a “total capability score” for each ship type was determined. I then compared the score to the daily operating cost of that ship to yield a dollar value for every point of capability the ship provides. The results of that dollar value demonstrate which ships the Navy should send in the wake of a crisis in order to maximize capability and minimize costs.

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II. LITERATURE REVIEW

A. THE RISE OF THE HUMANITARIAN ASSISTANCE DISASTER RELIEF MISSION

The U.S. Navy has dramatically increased its focus. on the Humanitarian Assistance and Disaster Relief over the last few decades. From 1970 to 2000, the Navy diverted 366 times for HA/DR operations (Thomas, 2003). These operations, however, were typically limited actions involving one or two ships, not the substantial movement of material and ships the world has come to expect (Sea Power for a New Era, 2009). The response to Indonesian Tsunami that occurred on December 26, 2004, was enormous. (Elleman, 2007). Within just ten days of the disaster, the U.S. Navy had 25 ships operating on-scene along with 58 helicopters and had already delivered over 610,000 pounds of food, water, and medical supplies (Elleman, 2007). The U.S. Navy was able to make a direct impact in helping the people of Sumatra, but this operation also had the indirect impact of enhancing diplomatic relations between the United States and Indonesia, which had an Islamic majority.

The Terror Free Tomorrow poll in February saw significant increases in Indonesian favorable public opinion towards the U.S. as a result of the U.S.'s HA/DR efforts (Terror Free Tomorrow, 2005). Further, over 75% of Indonesians believed at the time that the U.S. was "doing enough" to aid tsunami victims (Terror Free Tomorrow, 2005). Operating closely with the Indonesian military and government during the HA/DR response helped bring the two countries together, which was important to U.S. foreign policy. The United States also promptly lifted a previously imposed military supplies embargo against Indonesia and by May 2005, President Bush discussed resuming "normal military relations" (Elleman, 2007). The humanitarian aid the United States provided began to even improve relationships with other countries besides Indonesia. In the summer of 2006, then Secretary of the Navy Donald Winter declared, "[The United States has] seen significantly positive impacts in Indonesia, Pakistan and Horn of Africa as a direct result of our and other nations' humanitarian assistance and disaster relief (Elleman, 2007, p. 37).

Senior civilian and military leadership began to see the sizeable benefits of the HA/DR mission. The Center for Strategic and International Studies (CSIS), a prominent public policy think tank, established a bi-partisan commission to examine the potential for applications of smart power in 2006 (Albon, 2009). Co-chaired by policy experts Joseph Nye and Richard Armitage, the commission determined that the military would play a larger role in soft power execution, especially in the role of HA/DR (Albon, 2009). The commission specifically brought up the HA/DR mission in Indonesia as an example of how military assets could be Used to great effect for U.S. foreign policy goals (Albon, 2009).

By 2007, the U.S. Navy sensed a shift and set a new course for naval forces. While the nation focused their attention on protracted land engagements in Iraq and Afghanistan, Naval leadership, along with Coast Guard and Marine Corps participation, created a new strategy called the Cooperative Strategy for 21st Century Seapower (Allen, Conway, & Roughhead, 2007). The Cooperative Strategy (CS21) stressed the national security importance of having a flexible, responsive, and persistent naval surface force capability and included Humanitarian Assistance and Disaster relief into the Sea Services' core competencies (Allen et al., 2007). CS21 further highlighted the need for the naval services to practice a blend of "hard" and "soft" power. The hard power of the Sea Services was the capability to project power ashore and to control the sea, while the soft power was proactively engaging with international partners and potential partners to gain influence with a nation's leadership as well as positively shaping public perceptions of the United States (Allen, Conway, & Roughhead, 2007). This clear shift in strategy drew praise from numerous foreign policy experts. Gordon Lubold contended that Navy goodwill missions could become the Navy's essential tool in combating terrorism (Lubold, 2007). The Washington Post openly praised the new strategy upon its release (Tyson, 2007). Robert Kaplan of *The Atlantic* wrote an article entitled "America's Elegant Decline," in which he argued that only through an active and globally present Navy could the United States secure its great power status. (Kaplan, 2007) . He further stated that the concept of "hulls in the water" would be far more important in the 21st century than "boots on the ground" (Kaplan, 2007). Kaplan firmly believed in the CS21 plan and considered the HA/DR mission as one of the key areas of engagement performed by the United States Navy.

In the years since CS21, the Department of Defense has incorporated HA/DR into its strategic documents. The Quadrennial Defense Review (QDR) of 2010 performed by the Department of Defense discussed humanitarian assistance and disaster relief multiple times: four times in discussing building international relationships, once in regards to U.S. interagency cooperation, and once when discussing potential impacts of climate change (Defense, 2010). By 2011, HA/DR even became a core capability of the entire U.S. military as it was included in the National Military Strategy (NMS). The NMS had an entire section dedicated to the mission entitled "Theater Security Cooperation and Humanitarian Assistance."

Additionally, the U.S. Navy has incorporated the HA/DR mission into its overall recruiting campaign. Since 2010, the U.S. Navy has declared itself "A Global Force for Good," in a multitude of commercials and on its recruiting website (Navy, 2014). One commercial showed scenes of ships, aircraft and Sailors in a flooded area conducting search and rescue. Another showed Aircrewmen handing out supplies to children overlooking a devastated area. On the recruiting website, the Navy further explains what constitutes a "Global Force for Good" by saying that, "[the Navy is] a force that readily answers the need for humanitarian assistance and disaster relief anywhere, anytime – to help American citizens and citizens of the world" (Navy, 2014).

The Humanitarian Assistance and Disaster relief mission has without a doubt become a significant function of the United States Navy. As such, in an era of limited budgets, this mission should be further researched as to how the Navy can improve its capabilities regarding this new mission area while also considering costs at the same time.

B. HELICOPTERS: THE ESSENTIAL ASSET

When the Tsunami hit Sumatra in 2005, over 100 miles of coastline was devastated (Elleman, 2007). The coastal road was also useless, cutting off supplies by land to all the villages along the coast (Elleman, 2007). The only method in which the distraught people could quickly receive essential supplies was through the helicopter

(Elleman, 2007). Admiral Thomas Fargo, Commander of PACOM, stated that “helicopter vertical lift was vital to the success of the U.S. Navy’s humanitarian mission in Indonesia” (Elleman, 2007, p. 48). Further, then Secretary of State and former Chairman of the Joint Chiefs of Staff Colin Powell declared on January 5th that in Indonesia, “helicopters are invaluable, especially helicopters coming in from the sea, where they can be refueled and resupplied out on our carriers, and are not taking up space at airfields or putting a logistics base at airfields” (Gray, 2005). The Provincial Governor of Indonesia also considerably praised the helicopters, proclaiming that they “appeared like angels out of the sky” (U.S. Efforts Aid in Tsunami Relief, 2005).

Navy helicopters have the ability to fly over any terrain up 13,000 feet and provide assistance practically anywhere (NATOPS, 2007). Furthermore, if the terrain is too rough to land, the helicopter still has the ability to provide assistance by hovering low over the ground and dropping off needed supplies from the cargo hold. These assets also have a very low footprint where they can deliver the needed supplies and leave without the worry of offending the local population by staying. This became an issue in Sumatra in 2005 when the U.S.S. BONHOMME RICHARD wished to provide relief through its amphibious assault ships (Elleman, 2007). Bruce Elleman, in his thorough account of the Indonesian relief, describes the scene as such:

> Positioned off the city of Meulaboh, where only several thousand residents had survived out of an original population of sixty thousand, this ship had landing craft ready to put about a thousand Marines ashore. This movement was delayed, however, because it might appear to be an invasion. Aceh Province had been under the control of the Indonesian military, and it was thought that televised images of U.S. landing craft heading for the Acehnese coast “could touch a raw nerve with the proud and suspicious Indonesian military.” Finally, on 10 January 2005, a U.S. Navy LCAC—air-cushion landing craft—went ashore with thirty pallets of food and water. Only a few dozen personnel on Bonhomme Richard were allowed to go ashore each day. Also, instead of driving vehicles themselves to deliver aid—and risking traffic accidents that might spark anti-American anger, as had happened in places like South Korea—the Marines left final distribution of the supplies mainly to the Indonesian military. (Elleman, 2007, p. 80)

Aircrewmen using a helicopter can easily absolve them of political and cultural sensitivities by providing the necessary supplies and flying back to their home ship. Helicopters were truly essential to delivering supplies in Indonesia, as they were the only asset capable of doing so.

The situation in Indonesia with the devastated infrastructure is not unique for a HA/DR mission. Indeed, it is one element that is common in all of the HA/DR missions the Navy has performed since the Tsunami relief in Indonesia. Since then, the U.S. Navy has performed a HA/DR mission in eleven more devastated areas.

In 2005, Hurricane Katrina ripped through the Gulf Coast of the United States. Sustained winds of over 140 mph wrought havoc on the coastline and its catastrophic aftermath included flooding and devastated infrastructure (Hurricane Katrina, 2005). Even in the most industrialized nation in the world, the helicopter was crucial in providing need assets to stranded survivors.

Later that year, an earthquake rocked Pakistan with a massive 7.6 magnitude, leaving hundreds of thousands dead and millions without homes (Thompson, 2005). The Navy, in an effort to provide the most support possible, sent helicopters from Bahrain to provide support as it was the most important asset needed (Thompson, 2005). Lieutenant Commander Todd Vandegrift, Officer-in-Charge of HSC-26, said that his squadron would provide "flight relief, support, water, food, and shelter to distant portions of Pakistan [in order to go to the] parts most affected by the earthquake" (Thompson, 2005). He further went on to say that "this allows the United States and the U.S. Navy to support an important ally and lend support to those in need" (Thompson, 2005).

In February of 2006, a mudslide devastated three villages in the Philippines. The U.S. Navy was quick to respond and within days, the U.S.S *Essex* the U.S.S *Harpers Ferry,* and the U.S.S *Curtis Wilbur* were on scene to provide support (Truax, 2006) . That support was able to be provided because there were numerous. Helicopters stationed on board those ships that could deliver the needed assistance. They helicopters in that situation were able to provide essential relief supplies, perform a reconnaissance of the area, and drop off personnel able to help dig (Truax, 2006).

Hurricane Felix swept through much of Nicaragua in late 2007. Luckily, two U.S. Navy ships were nearby and could provide support because they had helicopters stationed onboard. The helicopters played a “major” role in the first week of the disaster mission, airlifting more than 125,000 pounds of relief supplies and medically evacuating 34 people during the initial frantic days after the storm (Wimbish, 2007). The relief mission commander stated that it was “It was our privilege to provide help to the Nicaraguan people in the aftermath of Hurricane Felix” (Wimbish, 2007). He further went on to say that it was a “demonstration of the close linkages among the people of the Americas coming to aid a partner nation,” highlighting the strategic value a well-performed HA/DR mission can provide to the United States (Wimbish, 2007) .

In another disaster relief mission, the U.S.S KEARSARGE arrived off the coast of Bangladesh to provide assistance in the wake of a Tropical Storm (Hossain, 2007). The United States was not well-loved by this country at the time, and demonstrators even chanted in their capital “Go back! We don’t want their warships!” (Hossain, 2007). The ship had twenty helicopters aboard and it was able to provide much-needed assistance solely because of these assets. Admiral Timothy Keating said that “we are here to help people in their time of need” (Hossain, 2007). This action helped improve relations with Bangladesh overall and demonstrated once again the value of the helicopter in a time of disaster.

The Philippines again faced natural disasters in 2008 and in 2009 when Tropical Storms hit the island nation. Within days of each disaster, a Carrier battle group had arrived on scene and provide much needed supplies (Fuentes, 2008) According to the U.S. Embassy, the carrier group “[supported] immediate rescue, recovery and disaster-relief efforts being carried out by Philippine authorities” (Fuentes, 2008). They were able to do this because they had helicopters, as they could not provide support any other way.

In every instance that the U.S. Navy provided relief in HA/DR missions, the helicopter was the essential asset. When determining how much capability a ship has in providing support for a disaster, one mU.S.t first look at how many helicopters the ship can bring, if any at all. While some ships can provide different types of support, this premier asset should be regarded as the highest priority.

III. DATA/METHODOLOGY

Data collection proved to be the most important and difficult part of this project. Attempting to locate the actual operating costs of the multitude of ships sent in relief proved to be very difficult. However, the articles by Greenfield and Ingram (2011); Ures (2011); Kaczur, Aurelio, and Joloya (2012); Herbert, Wharton, and Prosser (2012); and Apte, Yoho, Greenfield, and Ingram (2013) were beneficial in providing the background for organization of the data.

The Visibility and Management of Operating and Support Costs Center were essential to my research. The center maintains a database of every type/model/series in the Navy in order to provide cost estimators or Congress with historical data (VAMOSC, 2014). The historical data is the most important tool a cost estimator has to predict future costs. With a query, one could generate a report of a specific ship that had the total annual operating cost, including such variables as fuel costs and manpower, in any given year. Once I realized the database could generate such a specific report, I looked at what ships were sent during each of the three crises.

A. AVERAGE DAILY COST

The EM-DAT database contains specific data as to which ships the Navy sent in response to each crisis (EM-DAT, 2014). After compiling that list, one can go back to the VAMOSC database to request a report for those ships during the year that they responded to the disasters. Upon receiving the reports, I Used the ship inflation index in order to convert that dollar amount into a comparable number using 2015 dollars as a standard. The three tables, Tables 1, 2, and 3, describe the average daily cost of operations for each ship deployed or diverted for each of the three disasters: Indian Ocean Tsunami 2005, Haiti earthquake 2010, and Tohoku Japan earthquake 2011.

Table 1. Tsunami Relief Effort Indonesia 2005

	PLATFORM	Enroute Days	Days O/S	Annual Fuel Costs	Annual Operating Costs	Daily Fuel Costs	Daily Operating Costs
SHILOH	CG	8	32	$ 28,020,982.92	$ 69,734,654.98	$76,769.82	$ 191,053.85
BUNKER HILL	CG	4	20	$ 12,603,547.49	$ 67,858,358.56	$34,530.27	$ 185,913.31
ABRAHAM LINCOLN	CVN	8	32	$ -	$290,674,703.51	$ -	$ 796,369.05
BENFOLD	DDG	8	32	$ 24,086,415.48	$ 60,726,274.41	$ 65,990.18	$ 166,373.35
SHOUP	DDG IIA	8	32	$ 24,360,927.19	$ 57,176,568.07	$66,742.27	$ 156,648.13
MILIUS	DDG	4	20	$ 13,591,382.31	$ 60,109,784.91	$37,236.66	$ 164,684.34
THACH	FFG	4	20	$ 6,957,373.48	$ 37,994,240.56	$ 19,061.30	$ 104,093.81
SWIFT	HSV	27	33	$ 5,123,411.00	$ 11,692,310.00	$ 14,036.74	$ 32,033.73
WESTPAC EXPRESS	HSV	5	36	$ 8,183,415.00	$ 21,876,449.00	$22,420.32	$ 59,935.48
BONHOMME RICHARD	LHD	4	23	$ 35,926,108.69	$209,878,152.49	$98,427.70	$ 575,008.64
ESSEX	LHD	5	17	$ 31,970,152.98	$186,983,673.43	$87,589.46	$ 512,284.04
DULUTH	LPD	4	23	$ 11,895,427.91	$ 44,069,970.01	$ 32,590.21	$ 120,739.64
RUSHMORE	LSD	4	23	$ 10,724,923.87	$ 70,395,425.87	$29,383.35	$ 192,864.18
FORT MCHENRY	LSD	3	23	$ 10,107,607.64	$ 46,137,601.31	$27,692.08	$ 126,404.39
LOUISVILLE	SSN	8	0	$ 4,426.77	$ 25,015,918.02	$ 12.13	$ 68,536.76
PASADENA	SSN	4	0	$ 12,134.65	$ 28,987,911.50	$ 33.25	$ 79,418.94
SAN JOSE	T-AFS	3	53	$ 19,243,024.00	$ 56,853,590.00	$ 52,720.61	$ 155,763.26
CONCORD	T-AFS	3	20	$ 11,809,392.00	$ 50,067,891.00	$32,354.50	$ 137,172.30
NIAGARA FALLS	T-AFS	3	13	$ 14,251,408.00	$ 63,596,616.00	$39,044.95	$ 174,237.30
JOHN MCDONNELL	T-AGS	9	16	$ 1,433,731.00	$ 12,209,381.00	$ 3,928.03	$ 33,450.36
MERCY	T-AH	18	47	$ 12,688,238.00	$ 59,363,088.00	$34,762.30	$ 162,638.60
1ST LT JACK LUMMUS	T-AK	4	19	$ 6,382,660.00	$ 48,011,957.00	$ 17,486.74	$ 131,539.61
MAJ. STEPHEN W. PLES	T-AK	2	19	$ 18,817,120.00	$ 56,256,994.00	$ 51,553.75	$ 154,128.75
CPL. LOUIS J. HAUGE JR	T-AK	4	12	$ 8,287,218.00	$ 47,929,956.00	$ 22,704.71	$ 131,314.95
PFC. JAMES ANDERSON	T-AK	2	11	$ 7,126,549.00	$ 44,371,080.00	$ 19,524.79	$ 121,564.60
1ST LT. HARRY L. MART	T-AK	0	13	$ 6,464,093.00	$ 36,055,194.00	$ 17,709.84	$ 98,781.35
1ST LT ALEX BONNYMA	T-AK	4	18	$ 8,470,399.00	$ 48,113,801.00	$23,206.57	$ 131,818.63
TIPPECANOE	T-AO	0	26	$ 13,801,293.00	$ 41,628,842.00	$ 37,811.76	$ 114,051.62
RAINER	T-AOE	8	32	$ 25,066,234.00	$ 72,986,245.00	$ 68,674.61	$ 199,962.32

Table 2. Haiti Earthquake Response 2010

	Platform	Days Enroute	Days on Static	Annual Fuel Costs	Annual Operating Costs	Daily Fuel Costs	Daily Operating Costs
NORMANDY	CG	5	18	$ 18,472,617.09	$ 65,713,973.73	$ 50,609.91	$ 180,038.28
BUNKER HILL	CG	0	15	$ 12,839,639.98	$ 53,594,778.63	$ 35,177.10	$ 146,835.01
CARL VINSON	CVN	2	17	$ -	$ 380,653,676.24	$ -	$ 1,042,886.78
HIGGINS	DDG	2	12	$ 7,634,307.00	$ 54,045,513.11	$ 20,915.91	$ 148,069.90
HUAKAI	HSV	4	27	$ 8,980,487.00	$ 37,138,529.00	$ 24,604.07	$ 101,749.39
UNDERWOOD	FFG	1	20	$ 7,087,673.55	$ 31,243,662.47	$ 19,418.28	$ 85,599.08
NASSAU	LHA	5	17	$ 41,041,984.26	$ 149,344,468.39	$ 112,443.79	$ 409,162.93
BATAAN	LHD	4	65	$ 26,634,037.53	$ 159,775,128.12	$ 72,969.97	$ 437,740.08
KEARSARGE	LHD	1	0	$ 22,877,904.91	$ 177,470,565.17	$ 62,679.19	$ 486,220.73
MESA VERDE	LPD	5	17	$ 13,653,604.39	$ 56,231,411.30	$ 37,407.14	$ 154,058.66
FORT McHENRY	LSD	4	51	$ 3,024,109.29	$ 175,472,604.25	$ 8,285.23	$ 480,746.86
CARTER HALL	LSD	3	42	$ 10,809,590.01	$ 61,707,000.18	$ 29,615.32	$ 169,060.27
GUNSTON HALL	LSD	3	24	$ 7,697,419.56	$ 57,324,993.98	$ 21,088.82	$ 157,054.78
ASHLAND	LSD	5	17	$ 12,410,196.87	$ 71,413,530.25	$ 34,000.54	$ 195,653.51
CORNHUSKER STATE	T-ACS	10	42	$ 946,486.00	$ 3,139,111.00	$ 2,593.11	$ 8,600.30
GOPHER STATE	T-ACS	3	9	$ 622,292.00	$ 1,894,725.00	$ 1,704.91	$ 5,191.03
HENSON	T-AGS	0	11	$ 4,130,014.00	$ 16,624,883.00	$ 11,315.11	$ 45,547.62
COMFORT	T-AH	7	49	$ 4,490,374.00	$ 36,791,862.00	$ 12,302.39	$ 100,799.62
1ST LT JACK LUMMUS	T-AK	6	15	$ 8,785,619.00	$ 42,392,055.00	$ 24,070.19	$ 116,142.62
PFC DEWAYNE T. WILLI	T-AK	4	28	$ 5,080,970.00	$ 28,210,371.00	$ 13,920.47	$ 77,288.69
SACAGAWEA	T-AKE	14	14	$ 13,267,952.00	$ 61,444,074.00	$ 36,350.55	$ 168,339.93
LEWIS AND CLARK	T-AKE	6	18	$ 12,461,942.00	$ 59,827,892.00	$ 34,142.31	$ 163,912.03
CAPE MAY	T-AKR	4	44	$ 2,361,313.00	$ 5,907,342.00	$ 6,469.35	$ 16,184.50
BIG HORN	T-AO	5	20	$ 8,499,238.00	$ 45,025,314.00	$ 23,285.58	$ 123,357.02
LEROY GRUMMAN	T-AO	11	4	$ 7,954,483.00	$ 41,377,929.00	$ 21,793.10	$ 113,364.19
GRASP	T-ARS	5	61	$ 1,472,911.00	$ 17,696,781.00	$ 4,035.37	$ 48,484.33
CARIBE PIONEER/FOSS	TUG	1	22	$ 59,774.00	$ 693,549.00	$ 163.76	$ 1,900.13
ELSBETH II/BB-110	TUG	1	38	$ 170,023.00	$ 1,567,758.00	$ 465.82	$ 4,295.23
ALLIE B/MEMPHIS BRID	TUG	0	15	$ 188,192.00	$ 778,381.00	$ 515.59	$ 2,132.55
McALLISTER BOYS/ATL	TUG	7	15	$ 126,261.00	$ 1,091,562.00	$ 345.92	$ 2,990.58

Table 3. Tohoku Disaster Response 2011

	Platform	Days Enroute	Days on Station	Annual Fuel Costs	Total Annual Cost	Daily Fuel Cost	Daily Operating Cost
CHANCELLORSVILLE	CG	1	22	$ 27,309,174.00	$ 69,690,476.70	$ 74,819.65	$ 190,932.81
COWPENS	CG	2	21	$ 17,938,439.00	$ 71,164,853.31	$ 49,146.41	$ 194,972.20
SHILOH	CG	2	21	$ 4,898,678.00	$ 72,823,479.14	$ 13,421.04	$ 199,516.38
RONALD REAGAN	CVN	1	22	$ -	$346,279,611.60	$ -	$ 948,711.26
GEORGE WASHINGTON	CVN	0	0	$ -	$439,467,488.17	$ -	$ 1,204,020.52
PREBLE	DDG IIA	1	22	$ 17,624,283.00	$ 80,226,309.52	$ 48,285.71	$ 219,798.11
MUSTIN	DDG IIA	2	21	$ 16,392,195.00	$ 55,375,623.23	$ 44,910.12	$ 151,714.04
MCCAMBLE	DDG IIA	0	24	$ 15,533,788.00	$ 65,499,045.36	$ 42,558.32	$ 179,449.44
JOHN MCCAIN	DDG	1	22	$ 11,025,298.00	$ 50,546,144.97	$ 30,206.30	$ 138,482.59
CURTIS WILBUR	DDG	1	23	$ 11,485,218.00	$ 49,455,930.10	$ 31,466.35	$ 135,495.70
FITZGERALD	DDG	1	22	$ 16,246,998.00	$ 63,810,108.62	$ 44,512.32	$ 174,822.22
ESSEX	LHD	6	22	$ 24,853,098.00	$151,471,561.25	$ 68,090.68	$ 414,990.58
GERMANTOWN	LSD	6	22	$ 7,873,809.00	$ 46,270,808.77	$ 21,572.08	$ 126,769.34
HARPERS FERRY	LSD	6	22	$ 2,361,519.00	$152,970,226.16	$ 6,469.92	$ 419,096.51
TORTUGA	LSD	3	25	$ 5,698,340.00	$ 51,348,731.16	$ 15,611.89	$ 140,681.46
BLUE RIDGE	LCC	7	22	$ 12,320,072.00	$ 98,492,118.35	$ 33,753.62	$ 269,841.42
RICHARD E BYRD	T-AKE	0	6	$ 17,329,636.00	$ 51,350,236.00	$ 47,478.45	$ 140,685.58
CARL BRASHEAR	T-AKE	1	14	$ 14,635,129.00	$ 52,597,508.00	$ 40,096.24	$ 144,102.76
MATTHEW PERRY	T-AKE	3	20	$ 13,309,080.00	$ 45,177,029.00	$ 36,463.23	$ 123,772.68
PECOS	T-AO	0	17	$ 3,626,625.00	$ 33,412,203.00	$ 9,935.96	$ 91,540.28
RAPPAHANNOACK	T-AO	0	23	$ 8,059,244.00	$ 37,353,476.00	$ 22,080.12	$ 102,338.29
BRIDGE	T-AOE	1	22	$ 21,661,876.00	$ 63,547,769.00	$ 59,347.61	$ 174,103.48
SAFEGUARD	T-ARS	10	15	$ 1,848,331.00	$ 14,959,099.00	$ 5,063.92	$ 40,983.83
WESTPAC EXPRESS	HSV	1	7	$ 10,002,451.00	$ 22,087,524.00	$ 27,403.98	$ 60,513.76

The Navy sent a lot of different types of ships to respond to each disaster. Table 4 summarizes the results by describing the average daily cost by ship type across the disasters. These costs play a significant role in the financial analysis generated in this report.

Table 4. Average Daily Cost by Ship Type in 2015 U.S. Dollars

Ship Type	Average Daily Cost
CVN	$ 997,996.90
LHD	$ 485,248.81
LHA	$ 409,162.93
LCC	$ 269,841.42
LPD	$ 137,399.15
LSD	$ 223,147.92
CG	$ 184,180.26
DDG (FLT I and II)	$ 154,654.68
DDG (FLT IIA)	$ 176,902.43
Frigate	$ 94,846.44
SSN	$ 73,977.85
T-ACS	$ 6,895.67
T-AFS	$ 155,724.29
T-AGS	$ 39,498.99
T-AK	$ 120,322.40
T-AH	$ 131,719.11
T-AKE	$ 148,162.60
T-AO	$ 108,930.28
T-AOE	$ 187,032.90
T-ARS	$ 44,734.08
T-AKR	$ 16,184.50
TUG	$ 2,829.62
HSV	$ 63,558.09

B. CAPABILITY

Greenfield and Ingram (2011) analyzed capabilities of both U.S.N and MSC vessels by platform. The authors broke down the capability by “little to none,” “some,” and “very capable” and depicted their findings using a visual symbol method. The findings of Greenfield and Ingram are given in Appendix A, B, and C. Based on their research, Table 5 assigns a point system to each of the mission areas they identified and includes a new category for helicopters stationed aboard.

Table 5. Capability Score by Platform

	Helicopters Aboard	Helo Point Score	Aircraft Support	Landing Craft Support	Search and Rescue	Dry Goods	Refrigerated Goods	Fresh Water	Roll On Roll Off	Fuel	Self Sufficient	Personnel Transfer	Freshwater Production	Personnel Support	Berthing Capacity	Medical Support	Transit Speed	Hydrographic Survey	Salvage Ops	Towing	Total Capability Points
CVN	8	160	2		2	1	1	1		1	1	2	1	2	2	2	2				180
LHD	23	460	2	2	2	1	1	1		1	1	2	1	2	2	2	1				481
LHA	17	340	2	2	2	1	1	1		1	1	2	1	2	2	2	1				361
LCC	2	40	1	1	1	1						1		1	1	1	1				49
LPD	6	120	2	2	2	1					1	1		1	1	1	1				133
LSD		0	2	2	2	1					1	1		1	1	1	1				13
CG	2	40	1		1							1		1			2			1	47
DDG (FLT I and II)	0	0										1		1			2			1	5
DDG (FLT IIA)	2	40	1		1							1		1			2			1	47
Frigate	2	40	1		1							1		1			2			1	47
SSN	0	0	1	1	1	1	1	0	0	0	1	0		1	0	0	1				8
T-ACS		0										1		1			1				3
T-AFS	2	40	1									1		1			1				44
T-AGS		0										1		1			1	1			4
T-AK		0	1	1								1		1			1				5
T-AH	0	0	1	1	1	1	1	0	0	0	1	2		1	2	2	1				14
T-AKE	2	40	1			1					1	1		1			1			1	47
T-AO	0	0	1							2		1		1			1				6
T-AOE	2	40	1			1				2		1		1			1			1	48
T-ARS		0			1							1		1			1			1	5
T-AKR		0	1	1					2			1		1			1				7
TUG		0												0			1			1	2
HSV		0	1	1					1			1		1			2				7

The report above is a conglomeration of information gathered from each shipboard operational manual, located on the Navy Sea Systems Command website (Navy Sea Systems Command Manuals, 2014). As discussed in the literature review, the helicopter and the vertical lift capability it provides is an essential asset, the U.S. the assignment of a twenty point value for every helicopter stationed aboard each platform. I arrived at the number by averaging the approximate time the supplies could have been delivered had helicopters not been utilized in the three disasters. Using that methodology, the grade of 20 points is generous. Conservative scoring as it does not take into account political sensitivities or even whether or not the supplies could even be delivered by another method.

C. CAPABILITY SCORE VERSUS DAILY COST

The motivation for this report is to offer policy recommendations and a financial analysis of HA/DR operational costs and to provide an understanding of which platforms provide the most "bang for the buck." Table 6 describes cost per aggregated capability, which is calculated by comparing capability to the daily cost.

Table 6. Cost (U.S. Dollars) per Capability

Ship Type	Cost
LHD	$ 1,008.83
LPD	$ 1,033.08
LHA	$ 1,133.42
TUG	$ 1,414.81
Frigate	$ 2,018.01
T-ACS	$ 2,298.56
T-AKR	$ 2,312.07
T-AKE	$ 3,152.40
T-AFS	$ 3,539.19
DDG (FLT IIA)	$ 3,763.88
T-AOE	$ 3,896.52
CG	$ 3,918.73
LCC	$ 5,506.97
CVN	$ 5,544.43
T-ARS	$ 8,946.82
HSV	$ 9,079.73
SSN	$ 9,247.23
T-AH	$ 9,408.51
T-AGS	$ 9,874.75
LSD	$17,165.22
T-AO	$18,155.05
T-AK	$24,064.48
DDG (FLT I and II)	$30,930.94

The results are arranged in the ascending order of the total capability per U.S. dollar spent.

IV. DATA ANALYSIS

A. CAPABILITY ANALYSIS

Were the U.S. Navy not concerned at all with costs and just wanted to provide as much capability as possible, Table 7 depicts the most capable ships:

Table 7. Total Capability for each Ship

Ship Type	Capability Score
LHD	481
LHA	361
CVN	180
LPD	133
LCC	49
T-AOE	48
CG	47
DDG (FLT IIA)	47
Frigate	47
T-AKE	47
T-AFS	44
T-AH	14
LSD	13
SSN	8
T-AKR	7
HSV	7
T-AO	6
DDG (FLT I and II	5
T-AK	5
T-ARS	5
T-AGS	4
T-ACS	3
TUG	2

Figure 1 illustrates the capability of each of the platforms:

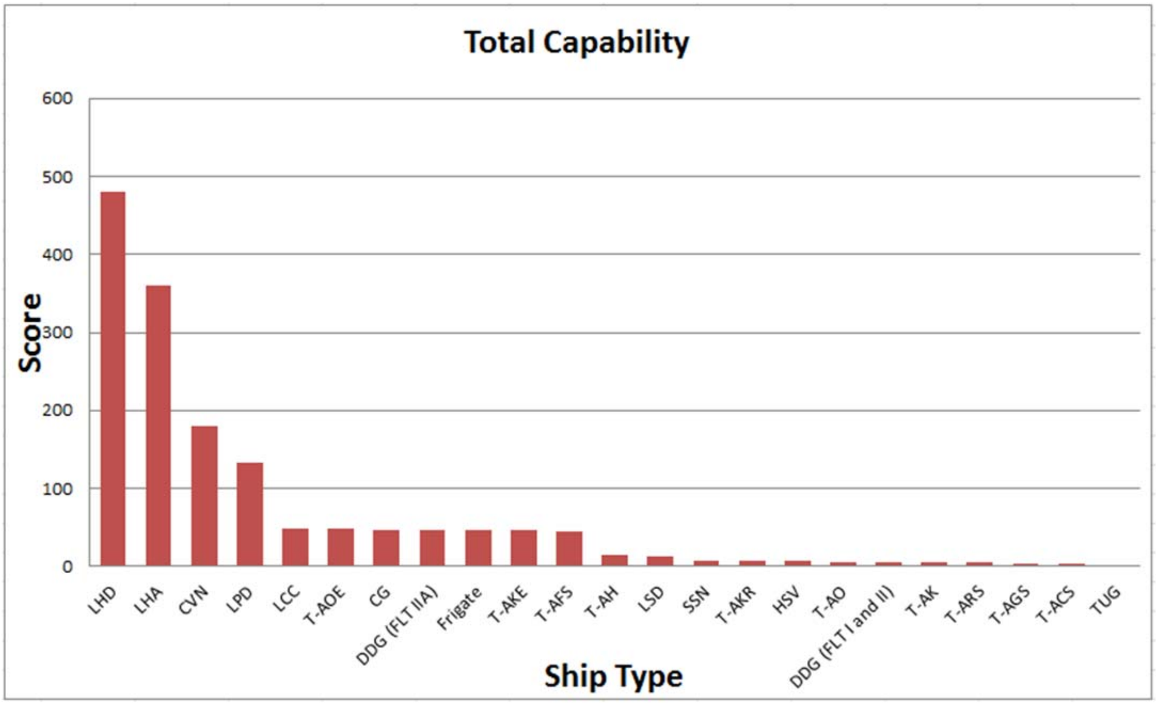

Figure 1. Capability Scores by Ship Type

With even the most cursory of glances at this chart, one can see that the true workhorses for the U.S. Navy in any Humanitarian Assistance and Disaster Relief Mission are going to be the LHD, LHA, CVN, and LPD platforms. Further, one can also see that any platform to the right of the T-AFS provides little to no HA/DR capability at all.

Comparison of cost in U.S. dollars for each ship with its total capability score offers some insight into the effects of sending an LHD versus a DDG Flight One when costs are accounted for (Figure 2).

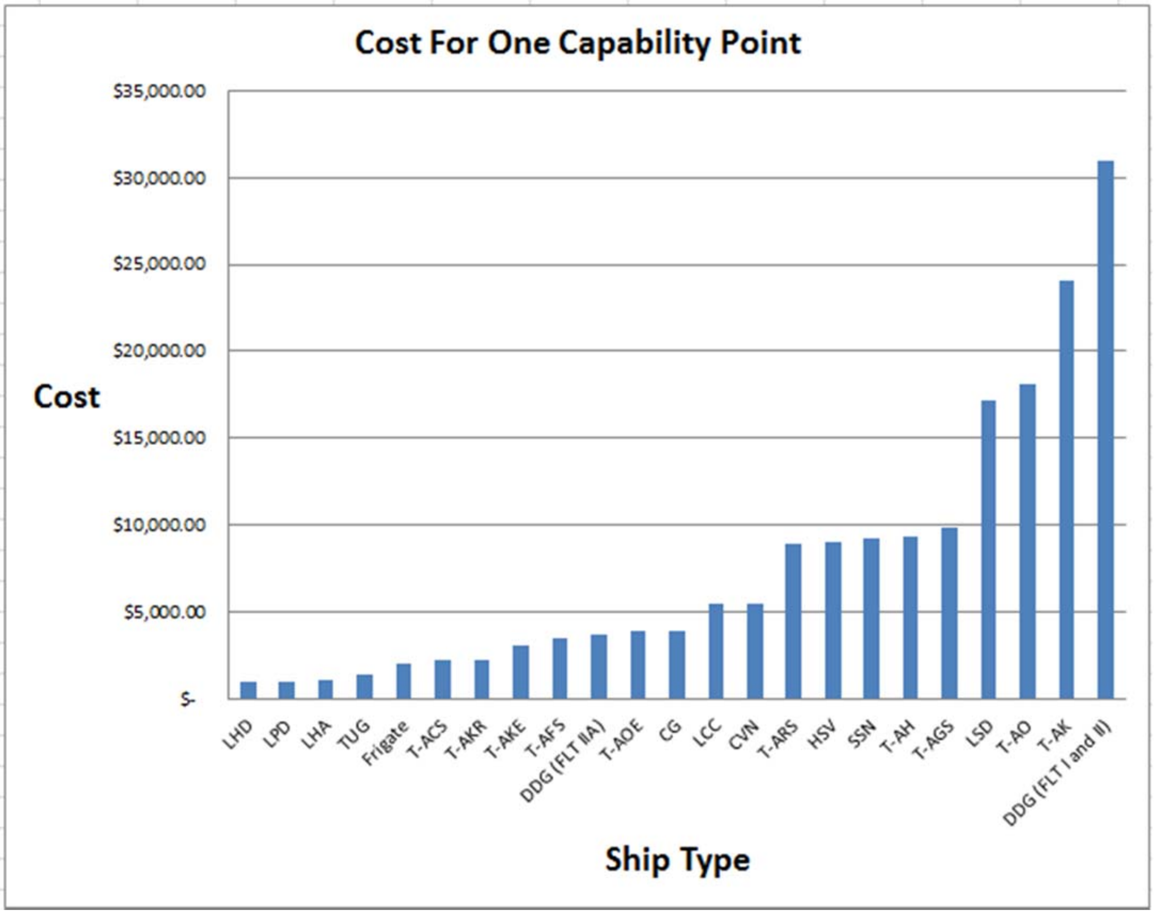

Figure 2. Cost vs. Capability

B. CAVEATS

The methodology used in this study is rudimentary and does not take into account some unusual circumstances which may be considered in future disasters. A large earthquake may entirely change the underwater topography of the area. This situation would strongly increase the value in sending a Hydrographic Survey Ship (T-AGS) to investigate the area. Many ships could have been disabled and require the use of Tug boats. Another instance might be that hospital beds are essential and circumstances may be such that a Mobile Army Surgical Hospital (MASH) cannot be established on the ground. In this case, the value of a Hospital Ship my rise tremendously. In the case of Indonesia, President Bush sent the slow-moving hospital ship U.S.S MERCY to relieve the U.S.S ABRAHAM LINCOLN. While the ship did not have nearly the capability as the aircraft carrier, sending the ship held great symbolic value as far as demonstrating support for the relief effort to the Indonesian people and the rest of the world. The U.S.S MERCY then began to help Indonesians with their regular medical needs and between February and June of 2005 treated over 9,500 patients (Elleman, 2007). Furthermore, some supply ships do not have a helicopter stationed onboard but they might be essential for the rest of the ships to continue further operations. Another aspect to consider is the defense of the ships providing support. Some DDG's that do not have helicopters on board may be essential in providing close-in defense of the Battle Group. Those decisions, however, rest with the Combatant Commander; the purpose of this report is merely to provide that commander with information which could help in providing capability for a disaster relief.

V. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

The purpose of this report is to offer Navy leadership a tool which they could use to determine which ships to send in the wake of a natural disaster. As the HA/DR has become a core competency during a time of limited budgets, it is important to consider cost effective methods of performing this mission. In the past, the U.S. Navy has sometimes sent many types of ships without due regard to their HA/DR capability. This is understandable, as most ships are designed to perform a variety of missions. This project studied what capabilities would contribute most to the HA/DR mission and determined that the helicopter is the most important asset many Navy ships have at their disposal during a disaster. After assigning a score to the various HA/DR capabilities with special consideration of the significance of the helicopter, one could determine a total capability score for each type of ship in the Navy. This report then studied the actual operating costs of every ship involved in three major disasters and determined which ships were the most cost effective.

The results clearly showed that the LHD, LHA, and the LPD were by far the most cost effective ships to send in the wake of a disaster. The report also showed that ship types such as the HSV, T-AO, T-AK, and a DDG without a helicopter aboard provided little HA/DR capability and were not cost effective. In future disasters, Navy leaders may look at Figures 8 and 9 to help them determine which ships to send to the area.

B. RECOMMENDATIONS FOR FUTURE STUDY

While realizing that it is sometimes difficult to break up the battle order of a Carrier Strike Group, Navy Leadership should take the HA/DR capability into account before diverting assets into a disaster area.

HA/DR stakeholders within the U.S. Navy should study the previous missions to ascertain which ships could have been cut from the response without causing any detriment to the overall response capability. One could use the tables established in this report as a baseline to determine an ideal solution from each of the disasters. This research could further be expanded by adding up the operating costs of the ships to demonstrate how much the U.S. Navy could have saved had it sent a more appropriate response.

Future force planners within the U.S. Navy should take into account the HA/DR mission as it chooses the most suitable platforms for the future. New aircraft such as drones may be valuable assets in the HA/DR mission. Providing a model for how many may be required may assist future planners in their estimates for the number the U.S. Navy should acquire.

As the U.S. Navy has incorporated HA/DR into its core competencies, further research could be done on the viability of future exercises having the mission as its primary purpose. Examination of the benefits of such an exercise could be worthwhile to explore. Further, one may consider having an expert in HA/DR on each of the Combatant Commanders' staffs. Research could be done on that what that person's background and schooling should be in order to offer the most effective advice.

APPENDIX A. CAPABILITY LABEL CLASSIFICATIONS

Empty Circle	○	The vessel has little no capability to conduct the specified mission
Half Filled Circle	◑	The vessel has some capability to conduct the specified mission
Filled Circle	●	The vessel is very capable in conducting the specified mission

(Source: Greenfield and Ingram, 2011)

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APPENDIX B. U.S.N PLATFORM CAPABILITIES

Missions to Platforms			Aircraft support	Landing Craft support	Search and Rescue	Cargo Capacity: Dry goods	Cargo Capacity: Refrigerated goods	Cargo Capacity: Fresh water	Cargo Capacity: Roll On Roll Off	Cargo Capacity: Fuel	Cargo Capacity: Self Sufficient	Personnel transfer	Freshwater Production	Personnel support	Berthing capability	Medical support	Transit speed	Hydrographic survey	Salvage Ops	Towing
U.S. Navy		CVN (Nimitz)	●	○	●	◑	◑	◑	○	◑	◑	●	◑	●	●	●	●	○	○	○
U.S. Navy		CVN (Enterprise)	●	○	●	◑	◑	◑	○	◑	◑	●	◑	●	●	●	●	○	○	○
U.S. Navy	Amphibious Ships	LHD	●	●	●	◑	◑	◑	○	◑	◑	●	◑	●	●	●	◑	○	○	○
U.S. Navy	Amphibious Ships	LHA	●	●	●	◑	◑	◑	○	◑	◑	●	◑	●	●	●	◑	○	○	○
U.S. Navy	Amphibious Ships	LCC	◑	○	◑	◑	○	○	○	○	○	◑	○	◑	◑	◑	◑	○	○	○
U.S. Navy	Amphibious Ships	LPD (San Antonio)	●	●	●	◑	○	○	○	○	◑	◑	○	◑	◑	◑	◑	○	○	○
U.S. Navy	Amphibious Ships	LPD (Austin)	●	●	●	◑	○	○	○	○	◑	◑	○	◑	◑	◑	◑	○	○	○
U.S. Navy	Amphibious Ships	LSD (Harpers Ferry)	●	●	●	◑	○	○	○	○	◑	◑	○	◑	◑	◑	◑	○	○	○
U.S. Navy	Amphibious Ships	LSD (Whidby Island)	●	●	●	◑	○	○	○	○	◑	◑	○	◑	◑	◑	◑	○	○	○
U.S. Navy	CRUDES	CG	◑	○	◑	○	○	○	○	○	○	◑	○	◑	○	○	●	○	○	◑
U.S. Navy	CRUDES	DDG (FLT I & II)	○	○	○	○	○	○	○	○	○	○	○	◑	○	○	●	○	○	◑
U.S. Navy	CRUDES	DDG (FLT IIA)	◑	○	◑	○	○	○	○	○	○	◑	○	◑	○	○	●	○	○	◑
U.S. Navy	CRUDES	Frigates	◑	○	◑	○	○	○	○	○	○	◑	○	◑	○	○	●	○	○	◑
U.S. Navy	Other	LCS (Freedom)	◑	○	◑	○	○	○	○	○	○	◑	○	○	○	○	●	○	○	◑
U.S. Navy	Other	LCS (Independence)	◑	○	◑	○	○	○	○	○	○	◑	○	○	○	○	●	○	○	◑
U.S. Navy	Other	PC	◑	○	◑	○	○	○	○	○	○	◑	○	○	○	○	●	○	○	◑
U.S. Navy	Other	MCM	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●

Mission / Ship Characteristic

(Source: Greenfield and Ingram, 2011)

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APPENDIX C. MSC PLATFORM CAPABILITIES

Missions to Platforms			Mission / Ship Characteristic																	
						Cargo Capacity														
			Aircraft support	Landing Craft support	Search and Rescue	Dry goods	Refrigerated goods	Fresh water	Roll On Roll Off	Fuel	Self Sufficient	Personnel transfer	Freshwater Production	Personnel support	Berthing capability	Medical support	Transit speed	Hydrographic survey	Salvage Ops	Towing
Military Sealift Command (MSC)	PM - 1	T-AOE	◑	○	○	●	●	●	○	●	◑	○	○	○	○	○	●	○	○	○
		T-AO	◑	○	○	●	●	●	○	●	◑	○	○	○	○	○	◑	○	○	○
		T-AE	◑	○	○	●	○	◑	○	●	◑	○	○	○	○	○	◑	○	○	○
		T-AKE	◑	○	○	●	●	◑	○	●	◑	○	○	○	○	○	◑	○	○	○
		T-ARS	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	●	●
		T-ATF	○	○	○	○	○	○	○	○	◑	○	○	○	○	○	○	○	◑	●
		T-AH	◑	○	○	○	○	○	○	○	○	◑	●	●	●	●	○	○	○	○
	PM - 2	LCC	◑	○	◑	◑	○	○	○	○	○	◑	○	◑	◑	◑	◑	○	○	○
		AS	○	○	○	○	○	○	○	○	◑	○	○	◑	○	○	◑	○	○	◑
		T-AGOS	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	○	◑
		T-AGS (Survey)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●
		T-AGS (Nav)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		T-AGM	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		T-ARC	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	○	◑
	PM - 3	LMSR	◑	○	○	●	●	●	●	●	●	○	◑	○	◑	○	◑	○	○	○
		MPS	◑	○	○	●	●	●	●	●	●	○	○	○	◑	○	◑	○	○	○
		MPF Container	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○
		T-AOT	○	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○
		T-AK (USAF)	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○
		T-AK (USA)	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○
		T-AVB	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○
		OPDS	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Break-Bulk	◑	○	○	◑	◑	◑	○	○	●	○	○	○	○	○	○	○	○	○
		HSV	○	○	○	○	○	○	○	○	○	●	○	○	○	○	●	○	○	○
	PM - 5	LMSR	◑	○	○	●	●	●	●	●	●	○	◑	○	◑	○	◑	○	○	○
		T-5	○	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○
		Common Use Tanker	○	○	○	◑	◑	●	○	●	◑	○	○	○	○	○	○	○	○	○
		Dry Cargo	○	○	○	●	●	◑	○	◑	●	○	○	○	○	○	○	○	○	○
	Ready Reserve Force	Fast Sealift Ship	◑	○	○	●	●	●	○	●	◑	○	○	○	○	○	●	○	○	○
		RO/RO ships	◑	○	○	●	●	●	●	●	●	○	◑	○	◑	○	◑	○	○	○
		Crane Ships	○	○	○	●	●	◑	○	◑	●	○	○	○	○	○	○	○	○	○
		Lighterage-aboard ships	○	○	○	●	●	◑	○	◑	●	○	○	○	○	○	○	○	○	○
		OPDT	○	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○
		Break-Bulk Ships	◑	○	○	◑	◑	◑	○	○	●	○	○	○	○	○	○	○	○	○
		Avaition Logistics Support	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○

(Source: Greenfield and Ingram, 2011)

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