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An Analysis of United States Naval Participation in Operation Tomodachi: Humanitarian and Disaster Relief in the Tsunami-Stricken Japanese Mainland

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June 2012

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The U.S. Department of Defense (DoD) has engaged in many humanitarian efforts over the years, such as the 2004 Indonesian tsunami and the 2010 Haitian earthquake. As military personnel are deployed around the globe, the DoD is in a good position to respond when called upon. The 2011 National Military Strategy focuses on maintaining a global presence to protect our national interest. The strategy further stressed the importance of force preparedness to support and respond to humanitarian crises. On March 11, 2011, this ability was tested when Japan was struck by a 9.0-magnitude quake followed by a subsequent tsunami. This project analyzes the U.S. naval response to the humanitarian crisis that resulted from the Tohoku earthquake and subsequent tsunami as part of Operation Tomodachi.

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AN ANALYSIS OF UNITED STATES NAVAL PARTICIPATION IN OPERATION TOMODACHI: HUMANITARIAN AND DISASTER RELIEF IN THE TSUNAMI-STRICKEN JAPANESE MAINLAND

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The U.S. Department of Defense (DoD) has engaged in many humanitarian efforts over the years, such as the 2004 Indonesian tsunami and the 2010 Haitian earthquake. As military personnel are deployed around the globe, the DoD is in a good position to respond when called upon. The 2011 National Military Strategy focuses on maintaining a global presence to protect our national interest. The strategy further stressed the importance of force preparedness to support and respond to humanitarian crises. On March 11, 2011, this ability was tested when Japan was struck by a 9.0-magnitude quake followed by a subsequent tsunami. This project analyzes the U.S. naval response to the humanitarian crisis that resulted from the Tohoku earthquake and subsequent tsunami as part of Operation Tomodachi.

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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

C7F	Commander, U.S. 7th Fleet
DoD	Department of Defense
DoS	Department of State
HADR	Humanitarian Assistance and Disaster Relief
JSDF	Japanese Self-Defense Force
MSC	Military Sealift Command
MST	U.S.–Japan Mutual Security Treaty
NGO	Non-Governmental Organization
SAR	Search and Rescue
USNUS	Navy

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I. INTRODUCTION

A. PURPOSE AND RESEARCH OBJECTIVE

The purpose of this research is to explore the utilization of U.S. Navy (USN) and Military Sealift Command (MSC) ships in supporting Operation Tomadachi between March 11, 2011, and April 8, 2011. Specific areas of analysis include U.S. Navy Humanitarian Assistance and Disaster Relief (HADR) response platform types and characteristics.

Operation Tomodachi is not the first large-scale HADR effort in which the U.S. Navy has engaged. Naval resources and capabilities were tested as recently as one year prior when a large 7.0-magnitude quake caused widespread devastation to the small island nation of Haiti. In addition, the HADR efforts for the 2004 Indian Ocean tsunami and 2005 Hurricane Katrina also relied on U.S. naval support in major ways.

Due to its capabilities, the U.S. Navy is often called to assist in disasters occurring in coastal regions when civilian response capability is overwhelmed in scale and scope. This project is intended to provide military and other disaster response planners with a tool to analyze the response pattern of USN and MSC vessels supporting Operation Tomodachi. The project provides a broad capability index with which to measure particular and cumulative mission area capabilities throughout the response and builds upon earlier work by Greenfield and Ingram (2011), who analyzed other U.S. naval responses to HADR events.

B. ORGANIZATION OF REPORT

This report is organized into six chapters. Chapter I is the introduction and provides the purpose and research objective. In Chapter II, we provide background information regarding the March 2011 Japanese earthquake and tsunami, the economic importance of Japan, and U.S.–Japan relations. Chapter III outlines the methodology for collecting and analyzing the empirical data. In Chapter IV, we compile the empirical data. In Chapter V and VI, we analyze the data collected, provide relevant conclusions, and make recommendations for further research.

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II. BACKGROUND

A. TSUNAMI AND EARTHQUAKE EFFECTS

Japan is a country of islands geographically located along the eastern, or Pacific, coast of Asia, commonly known as the volcanic zone in the Pacific Depth. It is an archipelago of about 145,882 square miles, bordered on the north and east by the Pacific Ocean and on the west by the Sea of Japan. Japan’s total population is estimated at 127.08 million people, with a growth rate of -0.278%. Although the country is comprised of more than 3,000 islands, the four main islands are Hokkaido, Honshu (or the mainland), Shikoku, and Kyushu (Department of State [DoS], 2012).

On March 11, 2011, at around 12:46 a.m. EST (2:46 p.m. Japan Standard Time), the country was hit by a 9.0-magnitude earthquake and subsequent tsunami, now known as the 2011 Tohoku earthquake and tsunami. The epicenter was located 80 miles east of Sendai, the capital of Miyagi Prefecture, and 231 miles northeast of Tokyo.

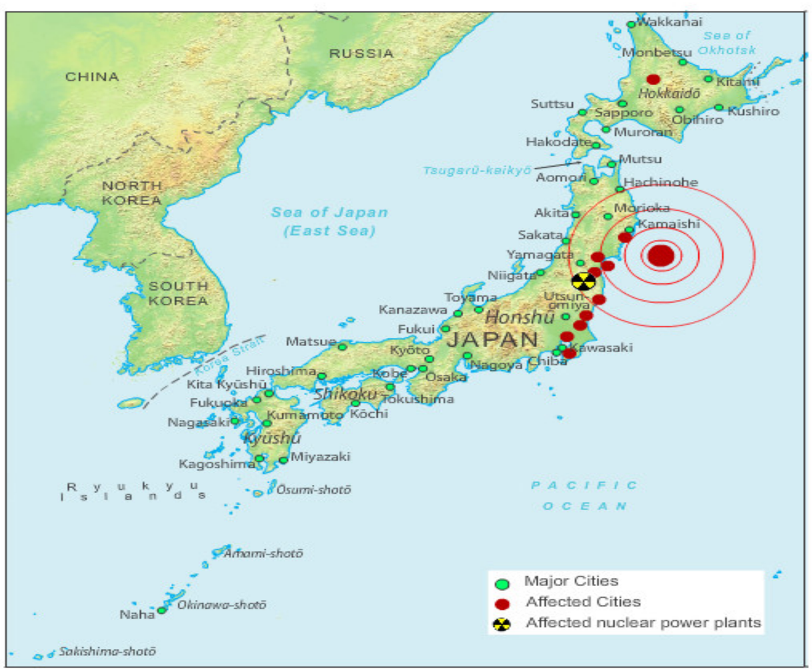

Figure 1. Map of Earthquake Epicenter (From Maps of the World, 2012)

Although Japan is a country prone to higher-magnitude earthquakes, this earthquake was the largest in Japan's recorded history and one of the deadliest in the world. Its death toll is estimated at 14,027 people, with 13,754 people missing. Furthermore, the disaster displaced over 136,000 people, destroyed over 4,500 buildings, and damaged 71 bridges, over 3,500 roads, and 26 railways. Table 1 is a snapshot of death toll by prefecture (Vervaeck & Daniell, 2011).

Table 1. Death Toll by Prefecture (From Vervaeck & Daniell, 2011)

Prefecture	Prefecture Name 2	Daytime Population	Deaths	Missing	Total Injured	Total People in Shelters (regardless of Prefecture)
Hokkaido	Hokkaido	5,507,456	1		3	1021
Aomori	Aomori-ken	1,373,164	3	1	61	815
Iwate	Iwate-ken	1,330,530	4,047	3,822	165	44515
Miyagi	Miyagi-ken	2,347,975	8,505	7,884	3436	43588
Akita	Akita-ken	1,085,878			12	539
Yamagata	Yamagata-ken	1,168,789	2		29	1438
Fukushima	Fukushima-ken	2,028,752	1412	2,044	227	26273
Tokyo	Tokyo-to	13,161,751	7		90	942
Ibaraki	Ibaraki-ken	2,968,865	23	1	693	677
Tochigi	Tochigi-ken	2,007,014	4		135	901
Gunma	Gumma-ken	2,008,170	1		35	2928
Saitama	Saitama-ken	7,194,957			42	3581
Chiba	Chiba-ken	6,217,119	18	2	224	1257
Kanagawa	Kanagawa-ken	9,049,500	4		139	695
Niigata	Niigata-ken	2,374,922			3	4695
Yamanashi	Yamanashi-ken	862,772			2	840
Shizuoka	Shizuoka-ken	3,765,044			4	755
Gifu	Gifu-ken	2,081,147				
Mie	Mie-ken	1,854,742			1	
Nagano	Nagano-ken	2,152,736				909
Miyakazi	Miyazaki-ken	1,135,120				
Tokushima	Tokushima-ken	785,873				
Kochi	Kochi-ken	764,596			1	
Total		73,226,872	14,027	13,754	5,302	136,369

As depicted in Table 1, the majority of the deaths occurred in Iwate, Miyagi, and Fukushima. The disproportionate casualty levels in these particular prefectures were not the result of the earthquake but the subsequent tsunami that inundated coastal areas surrounding the earthquake's epicenter.

In Miyako, the capital of Iwate Prefecture, the tsunami attained a maximum wave height of 125 ft, inundating various coastal areas. The same tsunami caused a dam failure in Fukushima, destroying approximately 1,800 homes and causing a majority of the casualties in that particular prefecture. In addition, the tsunami also caused the largest nuclear incident since Chernobyl when it severed the Fukushima Daichi nuclear power plant's power grid connections, causing overheating. The flooding and earthquake damage in the surrounding areas hindered external assistance, leading to a nuclear meltdown (United States Geological Survey [USGS], 2011).

The scale of the disaster may lead one to conclude that casualty and damage effects should have been significantly higher. However, over the last two decades, Japan made significant investments in nationwide disaster risk mitigation infrastructure. The country currently invests approximately 1.2% of its government's budget on disaster mitigation—a rate far above that of other industrialized countries. These investments include a ductile, earthquake-resistant design for new structures and retrofitting older construction, not just in Tokyo but across the nation. This investment resulted in the majority of buildings withstanding the original 9.0-magnitude quake and its sustained aftershocks (Center for Strategic and International Studies [CSIS], 2011).

In 2007, Japan also launched an advanced earthquake and tsunami warning system that triggers nationwide alerts via cell phone, radio, and television. This system was fully operational at the time of the March 2011 Tohoku earthquake and tsunami. Applicable alerts were expeditious, and the populace was well aware of where and when to relocate (CSIS, 2011).

Japan's mitigation planning scenarios were based on the 1896 Meiji Sanriku earthquake and tsunami. Although the events in Meiji Sanriku led to a large-scale disaster, forecasts based on this particular incident were not adequate for the tsunami triggered by the March 2011 quake. Evacuation sites were engineered to a maximum height of three stories vice the five to six stories required. In addition, sea walls had a maximum height of 10 meters and only three meters in Sendai and were, therefore, insufficient to prevent large-scale loss of life given the size of the tsunami. In addition, early detection systems failed to calculate the complete length of the earthquake and underestimated the tsunami's surge (CSIS, 2011).

Disasters of the magnitude generated by the 2010 Tohoku earthquake and tsunami often necessitate quick, large-scale coordinated responses. To assist in relief efforts, the U.S. Navy sent 24 ships, including a Carrier Strike Group and an Amphibious Ready Group, to the affected region around northern Japan.

B. ECONOMIC IMPACT OF THE EARTHQUAKE, TSUNAMI, AND NUCLEAR INCIDENT

Japan is one of the largest economies in Asia and the third largest in the world, with a 2010 gross domestic product (GDP) of $5.391 trillion/$34,200 per capita. The country is highly industrialized and extremely competitive in areas linked to international trade, with the exception of agriculture, natural resources, and services. Its society is highly urbanized, with only approximately 4% engaged in agriculture (Department of State, 2012).

Figure 2. Map of Japan (From Lonely Planet, 2012)

The Tohoku earthquake resulted in over $200 billion in economic damage and disruptions to the global production chain because Japan is a vital source for most of the world's advanced technology products. The earthquake also exacerbated challenges that the Japanese economy was already facing, including an aging population, deflation, and a large-scale national debt to GDP ratio. Japan's national government faces the difficult challenge of combating these demographic and structural economic challenges with the need for increased infrastructure spending required as part of disaster recovery (CSIS, 2011).

Japan is a major supplier for components in the automotive, electronics, and semi-conductor sectors. It is home to some of the world's largest automakers, including Toyota, Honda, and Nissan. In the Sendai region, manufacturing accounts for around one quarter of all production. The earthquake forced major international manufacturers, including Sony, Fujitsu, Toyota, and Hitachi, to suspend production at various plants throughout the region. Because many of the products produced in these plants were used to complete products at follow-on facilities, suspensions had cascading implications further down the supply chain (Nanto, Cooper, Donnelly, & Johnson, 2011).

C. OPERATION TOMODACHI AND U.S.–JAPAN RELATIONS

Operation Tomodachi (Japanese for *friend*) is the name given to the United States' humanitarian assistance and disaster relief operation in support of the Japanese mainland subsequent to the March 2011 Tōhoku earthquake and tsunami. The island nation hosts a large U.S. military presence, including bases in Misawa, Sasebo, Iwakuni, and Okinawa. Japan is home to the United States Navy's 7th Fleet, the largest U.S. numbered fleet. The U.S. Navy has approximately 70 ships, 300 various types of aircraft, and approximately 40,000 sailors and Marines operating in the region on any given day, providing a ready and capable presence. Over the course of the crisis, the United States and Japanese governments engaged in far-reaching cooperation, providing relief and aid to affected areas of northeast Japan (Commander, U.S. 7th Fleet [C7F], 2012).

Each disaster is unique, and the response structure is often tailored to the attributes of a particular disaster. In Japan, host nation infrastructure, economic development, extensive U.S. military regional presence, culture, and the unique U.S.–

Japan political relationship all influenced the structure of the HADR effort. Throughout the effort, the U.S. played a supporting role to the Japanese Self-Defense Force (JSDF).

The modern U.S. and Japanese military cooperative arrangement was established in 1951 with the U.S.–Japan Mutual Security Treaty (MST), whose heart resides in the collaborative work undertaken by the U.S. military and the JSDF. The joint response to the crisis highlighted the deep and far-reaching nature of the relationship and became a cornerstone of engagement between U.S. and Japanese military forces (Zielonka, 2011).

The U.S. Department of State (DoS) repeatedly emphasized that Operation Tomodachi was a reflection of the enduring nature of the U.S.–Japan Alliance. In remarks made at the University of Tokyo in October 2011, Deputy Secretary of State William Burns states:

> the U.S.–Japan alliance is the cornerstone of our engagement in the Asia-Pacific region . . . the United States is committed to the security of Japan and to strengthening peace and stability in the Asia-Pacific region . . . the success of what we called Operation Tomodachi provided a powerful demonstration of what we can accomplish together. (p. 1)

A strong and prosperous Japan is a key cornerstone of U.S. regional policy initiatives, and U.S.–Japanese mutual cooperation attempts to balance other destabilizing regional forces. Operation Tomodachi provided a clear and visible demonstration of this policy and the United States' commitment to its partnership with the Asia-Pacific nation.

Over the course of the operation, 16 U.S. naval ships and eight Military Sealift ships provided assistance and disaster relief efforts in and around the affected coastal areas of Japan. Military Sealift ships were engaged in relief supply transfer to responding U.S. naval ships. While U.S. naval ships engaged in a range of operations (e.g., search and rescue [sar], relief supply delivery ashore, JSDF and U.S. Troop movement, and aircraft refueling operations), units from all U.S. Services assisted with a multitude of capabilities ranging from medical, communications, relief supply, and civil engineering.

III. METHODOLOGY

A. DATA COLLECTION

We collected data from U.S. naval specific internet news sources, including C7F news archives and other web resource forums. Due to the extensive coverage of Operation Tomodachi, these resources proved largely sufficient in garnering the data required. In addition, participating personnel at various commands were also contacted and provided data obtained, by their command, during the course of Operation Tomodachi.

Data collected pertained to specific vessels that participated in Operation Tomodachi, including specific arrival and departure dates or dwell time, their time en route to the affected area, and the platform types and characteristics. This data was then catalogued into four primary tables broken down by platform capability, grading criteria, mission area capability, and the actual USN/MSC vessel response time line. By employing the same methodology as Greenfield and Ingram (2011), we place the U.S. naval response to Operation Tomodachi within the same framework as the responses to the 2004 Indian Ocean tsunami, 2005 Hurricane Katrina, and the 2010 Haitian earthquake analyzed by Greenfield and Ingram.

1. Disaster Traits

Japan's 2011 9.0-magnitude Tohoku earthquake and subsequent tsunami occurred near the northeast coast of Honshu (USGS, 2011). The U.S. Navy typically performs a larger role in responding to disasters occurring within coastal regions (Greenfield & Ingram, 2011). Since the Tohoku earthquake and tsunami bears many of the same traits as the disasters analyzed by Greenfield and Ingram (2011), it is applicable to include this response as part of that framework.

2. U.S. Naval HADR Response

This project provides a look strictly at which U.S. naval vessels were sent and does not attempt to ascertain why a particular vessel was sent. The data utilized to format the response table includes vessel type, arrival time, and duration of the vessel's HADR mission. Data was compiled from C7F official historical news archives and, as a secondary source, web news forums. Due to the extensive coverage of Operation Tomodachi, these sources proved sufficient to establish an accurate response time line.

3. USN and MSC Platform Capabilities

We utilize the platform capabilities of particular classes as they pertain to specific HADR mission areas, defined by Greenfield and Ingram (2011). These capabilities were used as input into specific HADR mission area capability and cumulative capability indexes to establish a broad view of the U.S. naval response capability throughout Operation Tomodachi.

IV. EMPIRICAL DATA

This chapter outlines the broad results of the devastation caused by the March 2011 Tohoku earthquake and tsunami and specific attributes of the disaster. It also defines the overall mission of Operation Tomodachi and the construct of the U.S. naval and MSC vessels responding in support of that operation. Additionally, it provides the response time line of these assisting vessels.

A. JAPANESE DISASTER TRAITS

The Japanese humanitarian crisis was the result of a 9.0-magnitude earthquake off the northeast coast of Honshu, Japan. The majority of the casualties occurred in and around Iwate, Miyagi, and Fukushima as the result of a subsequent tsunami with a maximum run-up height of approximately 125 ft. The tsunami also resulted in a nuclear reactor meltdown and crisis at the Fukushima Daichi nuclear power plant (USGS, 2011).

The 2011 Tohoku earthquake was the largest earthquake to strike Japan in recorded history. The largest earthquake prior was an 8.6-magnitude quake occurring in 1933. The area remains a hotbed of earthquake activity, and the March 2011 quake did not raise or lower the probability of future quakes in the region (USGS, 2011).

The overall effects of the Tohoku earthquake and tsunami are listed in Table 2.

Table 2. Effects of Japanese Tohoku Earthquake and Tsunami, 2011 (From Vervaeck & Daniell, 2011)

Deaths	> 14,000
injured	> 5,300
Missing	> 13,000
Displaced	> 136,000
Buildings Destroyed	> 95,300
Damaged Roads / Bridges	> 3,600

B. U. S. NAVY HADR RESPONSE

The U.S. response to the resulting humanitarian crisis subsequent to Japan's March 2011 earthquake was termed Operation Tomodachi. The U.S. naval response consisted of 16 warships, eight MSC vessels, and various aircraft and lasted approximately 30 days.

1. Force Construct

The ships involved in this response were primarily attached to the Reagan Carrier Strike Group, Essex Amphibious Ready Group, and Destroyer Squadron 15. The U.S naval platforms involved included one Nimitz Class Aircraft Carrier, one Wasp Class Amphibious Assault Ship, one Blue Ridge Class Command Ship, one Harpers Ferry Dock Landing Ship, two Whidbey Island Dock Landing Ships, several Guided Missile Cruisers, and several Flight I and II Guided Missile Destroyers.

Military Sealift vessels include three Lewis and Clark Class Replenishment Ships, two Henry Kaiser Class Oilers, one Supply Class Fast Combat Support Ship, one salvage vessel, and one high-speed vessel.

2. USN and MSC Vessel Response Time Line

Table 3 displays the response time line of the USN and MSC vessels supporting Operation Tomodachi. The table consists of the actual vessels responding to the disaster and their arrival and departure dates or dwell time. Its starting point is the day of the disaster.

A cell shaded light gray indicates that the vessel was ordered to respond, preparing for underway, or en route to the affected area on that particular day. Any cell shaded dark gray indicates that the vessel was on station assisting with relief efforts. Cells shaded black indicate that the vessel was released from HADR tasking and no longer supporting the operation.

An *N* has been placed in the cells applicable to USS *George Washington*. The vessel was required to get underway because it was undergoing shipyard maintenance availability and was unable to remain in the yard due to radiologic hazards associated with the nuclear meltdown at the Fukushima Daichi power plant. The George Washington did not significantly participate in the operation. Operation Tomodachi concluded on or around April 9, 2011, the date the last vessels terminated relief operations.

Table 3. Time Line of Operation Tomodachi Response (From C7F, 2011; Japan Bases, 2011; Baxter, 2011; Greenfield & Ingram, 2011)

	DAYS SINCE EARTHQUAKE		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
			MARCH																					APRIL										
Type	Name	Platform	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11
USS	CHANCELLORSVILLE	CG																									0							
USS	COWPENS	CG																									0							
USS	SHILOH	CG																									0							
USS	RONALD REAGAN	CVN																									0							
USS	GEORGE WASHINGTON	CVN											N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		
USS	PREBLE	DDG																									0							
USS	MUSTIN	DDG																									0							
USS	MCCAMBLE	DDG																									0							
USS	JOHN MCCAIN	DDG																									0							
USS	CURTIS WILBUR	DDG																									0							
USS	FITZGERALD	DDG																									0							
USS	ESSEX	LHD																														0		
USS	GERMANTOWN	LSD																														0		
USS	HARPERS PERRY	LSD																														0		
USNS	TORTUGA	LSD																														0		
USNS	BLUE RIDGE	LCC																														0		
USNS	RICHARD E BYRD	T-AKE																									0							
USNS	CARL BRASHEAR	T-AKE																									0							
USNS	MATTHEW PERRY	T-AKE																									0							
USNS	PECOS	T-AO																									0							
USNS	RAPPAHANNOACK	T-AO																									0							
USNS	BRIDGE	T-AOE																									0							
USNS	SAFEGUARD	T-ARS																														0		
MV	WESTPAC EXPRESS	HSV												0																				

C. SPECIFIC PLATFORM HADR MISSION CAPABILITY

This project applied the maritime platform capability classifications outlined by Greenfield and Ingram (2011) to the specific USN and MSC vessels responding as part of Operation Tomodachi. In accordance with this methodology, we evaluated vessel capability was evaluated using an ordinal scale ranging from 0 to 2 and assigned a symbol to each value.

1. Capability Classification

Table 4 defines the ordinal scale used to evaluate vessel capabilities.

Table 4. Capability Classification (From Greenfield & Ingram, 2011)

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

These capabilities feed into Table 5, which outlines the specific Mission Capability Parameter Definitions established by Greenfield and Ingram (2011). These mission areas are specifically related to HADR operations and do not reflect the overall combat capability of a particular platform. Although a vessel's combat capability plays a certain role in aiding HADR mission effectiveness, it is not the sole determinant of a ship's capability in the HADR mission arena.

Table 5. Mission Capability Parameter Definitions (From Greenfield & Ingram, 2011)

			Capability Defined
Critical Mission Capabilities	**Aircraft support**	○	No embarked helo, unable to support helicopter operations
		◑	Single helo embarked, able to support a majority of helo platforms
		●	Multiple helos embarked, able to sustain multiple flight operations simultaneously
	Landing Craft support	○	No ability to support landing craft
		◑	Some ability to support landing craft
		●	Landing craft embarked, able to load / off load cargo and store amphibious vehicles
	Search and Rescue	○	No embarked helo, unable to efficiently conduct SAR missions
		◑	Single embarked helo with communication equipment and night vision
		●	Multiple helos embarked with communication equipment and night vision
	Cargo Capacity: **Dry goods**, **Refrigerated goods**, **Fresh water**, **Roll On Roll Off**, **Fuel**, **Self Sufficient**	○	No ability to store good beyond current ship use
		◑	Ability to store some supplies beyond ship's use
		●	Ability to store and transfer mass amount of supplies
	Personnel transfer	○	No ability to support personnel transfer, slow speed vessel with deep draft
		◑	Ability to support personnel transfer for 15+ personnel
		●	High speed, shallow draft vessel with ability to transport 30+ personnel per voyage
	Freshwater Production	○	no ability to produce freshwater beyond shipboard usage
		◑	Ability to produce and transfer >2,000 gallons per day beyond shipboard usage
		●	Able to produce and transfer > 5,000 gpd beyond shipboard usage
	Personnel support	○	Low crew number to support HADR mission (< 50 personnel)
		◑	Medium size crew which can support HADR mission (51 - 200 personnel)
		●	Large crew with ability to support HADR mission (> 200 personnel)
	Berthing capability	○	Little to no excess berthing or facilities (< 30 racks)
		◑	some excess berthing and facilities (31-50 racks)
		●	large number of excess berthing and facilities (> 50)
	Medical support	○	No ability to conduct inpatient medical treatments, no Medical officer embarked
		◑	Some medical support onboard, ability to support minor medical procedures
		●	Medical officer embarked, ability to perform surgeries and hold several patients
Non-Critical Mission capabilities	Transit speed	○	0-18 knots max speed
		◑	19-24 knots max speed
		●	25 + knots max speed
	Hydrographic survey	○	no ability to conduct hydrographic surveys
		◑	some ability to conduct hydrographic surveys, soundings and chart building
		●	Able to conduct hydrographic surveying, soundings and chart development
	Salvage Ops	○	No ability to conduct salvage operations
		◑	some ability for lift and salvage operations in shallow waters
		●	heavy lift and deep water salvage capable
	Towing	○	No ability to conduct towing operations
		◑	Ability to conduct emergency towing operations
		●	Designed to conduct push, pull, or alongside towing operations

Capability classifications were the basis for developing the full assessment of a platform's HADR mission capability. We applied the same specific capability parameters, assigned to particular USN and MSC vessel classes, as established by Greenfield and Ingram (2011) to enable scoring of overall maritime vessel mission capability during Operation Tomodachi. The capability comparisons of USN and MSC vessel platforms are listed in Tables 6 and 7.

Table 6. USN Platform and Capability Comparison (From Greenfield & Ingram, 2011)

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
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	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●

Table 7. MSC Platform and Capability Comparison (From Greenfield & Ingram, 2011)

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	◑	○	○	●	●	●	○	●	●	○	○	○	◑	○	◑	○	○	○

These tables outline an easily comprehendible comparison of the capabilities and limitations of particular vessel classes available to the U.S. Navy in responding to humanitarian crises. The most capable USN vessels are the amphibious ships due to their unique design for amphibious surface assault with embarked Marine units, leading to high capability in the HADR mission areas of aircraft support, landing craft support, and berthing. In addition, large-deck amphibious vessels also have high medical support capability due to their onboard treatment facilities and embarked medical detachments. Aircraft carriers are also comparable with amphibious vessel capability with the exception of landing craft support (Greenfield & Ingram, 2011).

MSC vessels are highly capable in the area of cargo, fuel, and freshwater storage capacity but are primarily designed around transferring these stores from vessel to vessel vice vessel to shore. This limits their overall effectiveness in the HADR arena. In addition, MSC vessels frequently have small crew sizes and lack embarked helicopter units, thus limiting them in the areas of aircraft support and SAR. They are, however, essential in getting large amounts of supplies to the affected area for further transport via alternative means (Greenfield & Ingram, 2011).

The capability parameters of the vessels are utilized in the Analysis chapter to establish a scoring of on-scene mission capability relative to the disaster response time line. The parameters do not indicate whether one vessel is a certain percent more capable than another or attempt to identify an optimal response level. Rather, it utilizes the three qualitative categories, defined in Table 3, along with the number of ships on station, to establish a broad view of USN and MSC vessel response capability as Operation Tomodachi unfolded (Greenfield & Ingram, 2011).

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V. ANALYSIS

This chapter analyzes the particulars of the USN and MSC vessel response time line depicted in Table 3. It also provides and analyzes mission capability achieved as part of the response, utilizing the framework established in the previous chapter. In addition, it compares and contrasts the USN response time line and capabilities during Operation Tomodachi with the three previous responses (the 2004 Indian Ocean tsunami, 2005 Hurricane Katrina, and the 2010 Haitian earthquake) analyzed by Greenfield and Ingram (2011).

A. RESPONSE TIMELINE ANALYSIS

Figure 3 displays the number of vessels on station by day beginning with the day of the disaster itself. Day 1 corresponds to March 11, 2011, the day of the Tohoku earthquake and tsunami. This graphic is taken directly from the USN and MSC response time line depicted in Table 3.

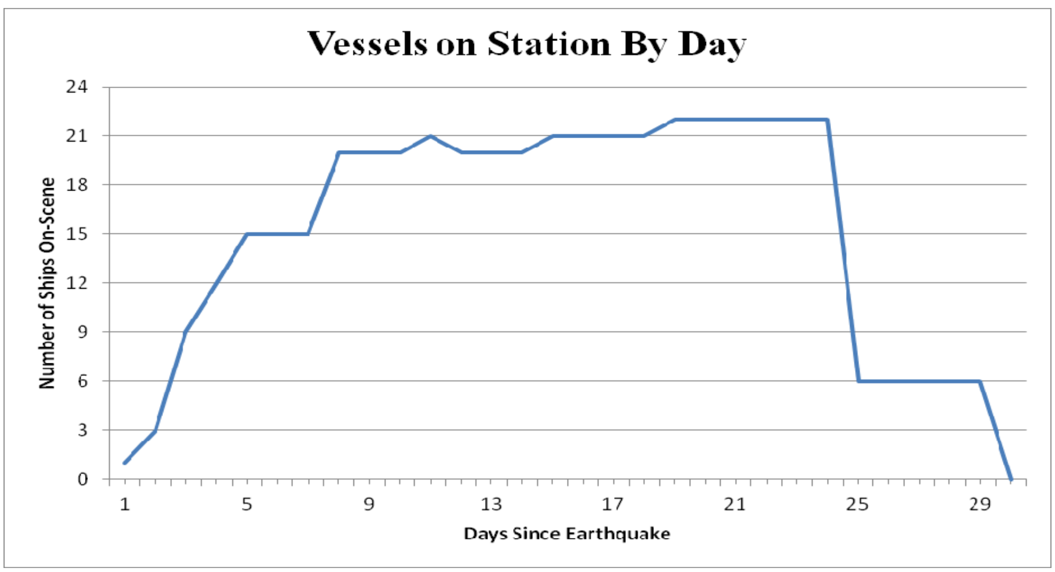

Figure 3. Vessels on Station by Days After the Disaster

The most striking feature of Figure 3 is the rapid response rate of the vessels assigned to respond as part of Operation Tomodachi. On the first day of the disaster, one ship, USS *McCampbell* (DDG 85), was already on scene since it was operating in the vicinity of the disaster zone. By Day 4, 12 vessels, including all elements of the Reagan Carrier Strike Group, were on station assisting relief efforts. The Essex Amphibious Ready Group arrived on Day 8, bringing the total number of vessels on station to 20. The number of vessels on station peaked at 22 vessels on Day 19. By Day 25, the majority of relief operations had concluded and the Reagan Carrier Strike Group departed for follow-on tasking. Operation Tomodachi ended 30 days after the disaster, after which elements of the Essex Amphibious Ready Group departed the affected region.

In addition, the main elements of the Essex Amphibious Ready Group—in particular, USS *Essex* (LHD 2), USS *Germantown* (LSD 42), and USS *Harpers Ferry* (LSD 49)—took approximately eight days to arrive on station because of their relative distance from the disaster region and the time needed to load relief supplies. The Essex Amphibious Ready Group's remaining element, USS *Tortuga* (LSD 46), began assistance efforts approximately three days prior, on Day 5, since the vessel was in Sasebo and closer to the affected region.

We noted several factors that contributed to the rapid naval response and force positioning during Operation Tomodachi. These factors include, but are not necessarily limited to, the U.S. 7th Fleet commander's ordering of a posturing of forces immediately after the disaster struck the Tohoku region; no serious damage to 7th Fleet assets in the region, including infrastructure at naval base Yokosuka; Reagan Carrier Strike Group elements within minimal steaming distance from the affected region; a higher state of required logistical readiness for deployed and forward-deployed vessels within the 7th Fleet; and a significant number of USN and MSC ships already operating in the region.

B. COMPOSITE MISSION CAPABILITY

Table 8 provides the mission composite capability during Operation Tomodachi. The table begins on Day 1 of the disaster and corresponds directly to the start of Operation Tomodachi. Table 8 was formulated utilizing the various USN and MSC platform HADR capabilities identified in Tables 6 and 7 in the previous chapter. In accordance with the capability classifications outlined in Table 4, a filled circle assigned the platform a score of 2 for a particular mission area, a half-filled circle assigned it a score of 1, and an empty circle assigned a score of zero. The results for each platform were combined utilizing the capability levels identified in Tables 6 and 7 along with the vessel response time line, providing a cumulative mission capability index for each day of the response. The higher the composite score, the greater the response capacity was for that particular timeperiod (Greenfield & Ingram, 2011).

Table 8. Mission Composite Capability Time Line: Operation Tomodachi (From Greenfield & Ingram, 2011)

DAYS SINCE EARTHQUAKE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	MARCH																					APRIL												
Critical Capability	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13
Aircraft Support	1	2	7	10	13	13	13	21	21	21	21	22	22	22	22	22	22	22	23	23	23	23	23	23	23	9	9	9	9	9				
Landing Craft Support					2	2	2	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8				
Search and Rescue	1	1	5	8	10	10	10	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	9	9	9	9	9				
Dry Goods		2	5	5	8	8	8	14	14	14	16	16	16	16	16	16	16	16	18	18	18	18	18	18	18	5	5	5	5	5				
Refrigerated Goods		2	5	5	8	8	8	13	13	13	15	15	15	15	15	15	15	15	17	17	17	17	17	17	17	4	4	4	4	4				
Fresh Water Cargo		2	5	5	6	6	6	9	9	9	10	10	10	10	10	10	10	10	11	11	11	11	11	11	11	1	1	1	1	1				
Roll On Roll Off																																		
Fuel		2	3	3	5	5	5	8	8	8	10	10	10	10	10	10	10	10	12	12	12	12	12	12	12	1	1	1	1	1				
Self Sufficiency		1	3	3	5	5	5	9	9	9	10	10	10	10	12	12	12	12	13	13	13	13	13	13	13	6	6	6	6	6				
Personnel Transfer	1	1	5	8	11	11	11	16	16	16	16	16	14	14	14	14	14	14	14	14	14	14	14	14	14	6	6	6	6	6				
Fresh Water Production			1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1				
Personnel Support	1	2	8	11	12	12	12	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	6	6	6	6	6				
Berthing Capability			2	2	3	3	3	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	6	6	6	6	6				
Medical Support			2	2	3	3	3	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	6	6	6	6	6				
Cumulative Capability	4	15	51	63	87	87	87	150	150	150	158	159	157	157	159	159	159	159	168	168	168	168	168	168	168	68	68	68	68	68				

Table 8 indicates that cumulative capability peaked on Day 19 at 168 when all responding vessels were on station. The majority of mission capability was achieved by Day 8, when capability reached 150. This was due to the arrival of the remaining Essex Amphibious Ready Group and its significantly greater capacity for HADR response relative to other responding vessels, including the Carrier Strike Group. For instance, the relative capability increased by approximately 50 on Day 3 when the Reagan Carrier Strike Group arrived on station, but it increased by 87 as members of the Essex Amphibious Ready Group arrived.

The response effort was initially executed utilizing a Carrier Strike Group and Expeditionary Strike Group operating model. As identified by Greenfield and Ingram (2011), the same model was utilized by the U.S. Navy in responding to the 2004 Indian Ocean tsunami. Although the Indian Ocean tsunami covered a wide area, the U.S. Navy concentrated most of its response effort in the hardest hit area of western Indonesia, and it was a 7th Fleet–centered operational response. On or around March 15, 2011, the fourth day into the response effort, the naval response effort transitioned into the Joint Task Force model (C7F, 2011).

C. DISASTER RESPONSE COMPARISON

Figure 4 displays the cumulative mission composite capability of Operation Tomodachi in relation to the cumulative mission composite capability of the 2004 Indian Ocean tsunami, 2005 Hurricane Katrina, and the 2010 Haitian earthquake calculated by Greenfield and Ingram (2011).

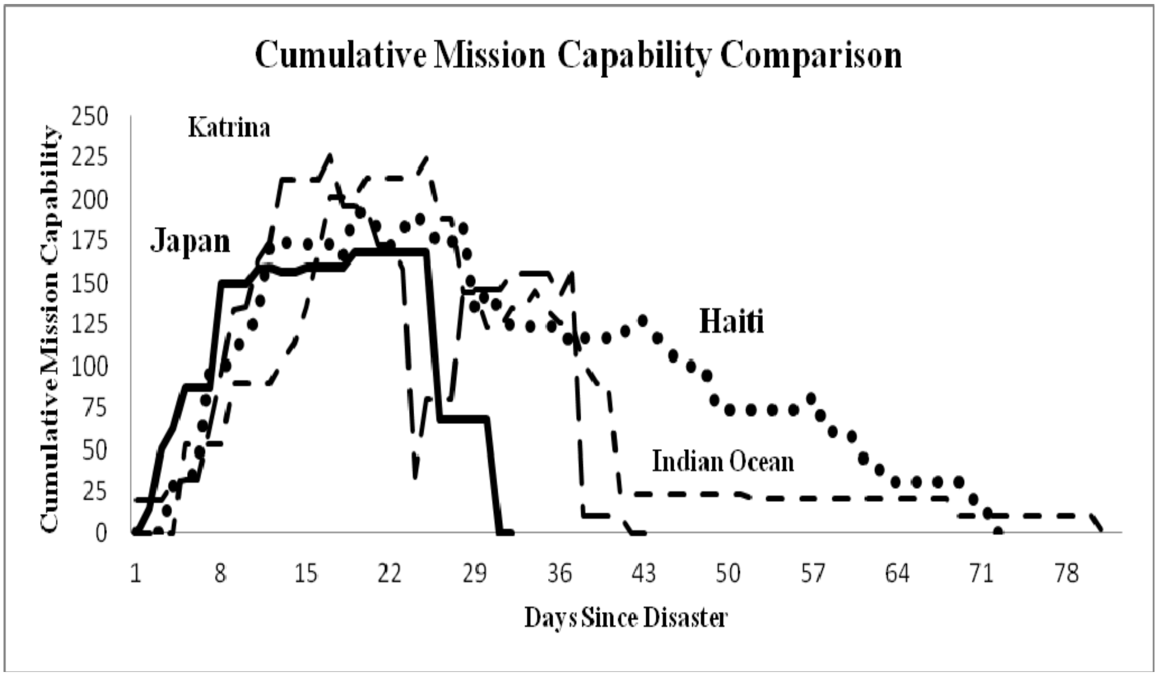

Figure 4. Cumulative Mission Capability Comparison (From Greenfield & Ingram, 2011)

In contrast to the other disasters, peak response efforts in Japan occurred far more rapidly and tapered off much more quickly than the other three disasters depicted in the table. In Operation Tomodachi, peak response levels began at Day 8, at least five days prior to the peak response period of Hurricane Katrina and four days prior to the peak response levels of the 2010 Haitian earthquake.

In addition, beginning at Day 26, Operation Tomodachi's response effort declined dramatically, and it officially ended at Day 31. It experienced the most rapid termination of any of the disasters depicted, although several days before Operation Tomodachi's termination, the response effort appears to resemble that of Hurricane Katrina, which terminated around Day 37. Around Day 23, the response effort to Hurricane Katrina experienced a significant drop in mission capability. This was due to the evacuation of naval vessels from the disaster area in preparation for Hurricane Rita, which was poised to strike the Gulf Coast, and not due to an intended reduction in the level of operations (Greenfield & Ingram, 2011).

Operation Tomodachi was truncated primarily by the desire of the United States government to assist the Japanese government in its time of need and avoid the impression that the U.S. military was maintaining a permanent presence in the affected area. In contrast, Hurricane Katrina's response was quickly terminated due to the presence of DoS and non-government-organization (NGO) actors that assumed the responsibilities initially shouldered by the military (Greenfield & Ingram, 2011).

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VI. CONCLUSION

A. RAPIDITY OF INITIAL RESPONSE

One of the remarkable aspects of Operation Tomodachi was the speed of initial response by U.S naval vessels. We noted several contributing factors that enabled a faster initial response during Operation Tomodachi than in the three disasters analyzed by Greenfield and Ingram (2011). These factors include the close proximity of U.S. naval and MSC vessels to the affected region, the U.S. 7th Fleet's ordering force pre-positioning the day of the disaster, no major damage to naval base infrastructure in the region, the higher level of logistical readiness maintained by forward-deployed U.S. naval forces, and the mutually positive relationship existing between the U.S. and Japanese governments.

Each of these factors contributed to the rapidity of the initial response to a greater or lesser degree. We did not determine the actual weight that each of these had because this would involve data collection and analysis outside the scope of this project. It is our intention to simply bring these observations to light in order to benefit operational planners and future decision-makers.

B. UNIQUE AND SPECIAL CONSIDERATIONS

The extent of Japanese earthquake and tsunami preparedness played a crucial role in mitigating infrastructure damage and death toll in the affected regions of northern Japan. Although it is impossible to plan for every scenario, a major lesson of the March 2011 Tohoku earthquake and tsunami is that well-planned disaster mitigation initiatives do work and can save a considerable number of lives. This is evidenced in Table 1, by the very small percentage of missing and dead, as a part of total daytime population, in the affected prefectures.

We observed that online social message forums, such as Facebook, played an increasing role in informing the general populace about the extent of damage to affected regions and the ongoing efforts by first responders, including the U.S. Navy. U.S. 7th

Fleet regularly updated its Facebook page with unclassified releasable response information normally contained in its public affairs webpage. This adds an additional dimension to public communication not without its own challenges. For instance, although social media can provide citizens with real-time information regarding the disaster, it can also complicate matters in the event of an inadvertent release of sensitive information.

In addition, language barriers existing between responders and the indigenous population inhibited the determination of required relief supplies to at least some degree. This problem is not unique to Operation Tomodachi and will be encountered during almost any HADR operation conducted by the U.S. military outside North America. Operational planners should consider more widespread use of easy-to-implement items, such as laminated cards, that responders can utilize to determine the immediate needs of the local civilian population to speed-up delivery of needed materials.

The 2011 Japanese humanitarian crisis is unique in that it is a compilation of at least three individual and interrelated disasters. The first is the earthquake itself, the second is the subsequent tsunami, and the third is the fallout from the Fukushima nuclear reactor meltdown. Due to the magnitude of the crisis, this project only begins to scratch the surface regarding the overall response effort and scope. Further research, by subsequent project teams, is definitely warranted and will only serve to benefit planners and decision-makers, enabling a more structured and capable mitigation/response framework.

C. FUTURE RESEARCH RECOMMENDATIONS

Table 9 contains a list of future research recommendations based on the limits to our research and areas identified during the data collection and analysis process that warrant further study.

Table 9. Future Research Recommendations

Conduct an in-depth analysis of the Fukushima nuclear disaster that occurred as a result of the March 2011 Tohoku earthquake and tsunami.
More in-depth analysis of the role the other uniformed services played during Operation Tomodachi.
Identify and thoroughly analyze the specific HADR capabilities of vulnerable countries within the *Rim of Fire*.
Analyze the feasibility of developing an HADR response package that can be tailored to an individual country's organic capability.

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