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AN ANALYSIS OF PHILIPPINE AND JAPANESE NAVAL ASSETS FOR HUMANITARIAN ASSISTANCE AND DISASTER RELIEF (HADR) OPERATIONS

by

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June 2022

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13. ABSTRACT (maximum 200 words)

Located in the Typhoon Belt of the Pacific, the Philippines and Japan experience strong tropical cyclones every year that affect millions of people living near or within the coastal areas. When the magnitude of a disaster reaches a national level of response, the navies of both countries are mandated to augment other government agencies in support of disaster relief and response operations. Because time is of the essence, ships ready for sea near the affected areas are usually the immediate choice for deployment. We analyze the strongest tropical cyclones that devastated both countries and the resulting government responses to determine the most efficient and effective type of ship for Humanitarian Assistance and Disaster Relief (HADR) operations. The parameters we use in the analysis are the ships' current capabilities, the process to select ships for deployment, and the HADR policies of both countries, which result in the recognition of critical and non-critical ship's capabilities. The analysis also reveals the potential use of the amphibious capability for humanitarian logistics in coastal areas. This research may also serve as a guide for the United States Navy or other foreign navies in sending ships to any countries in East Asia and the Pacific region whenever international support is sought.

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ABSTRACT

Located in the Typhoon Belt of the Pacific, the Philippines and Japan experience strong tropical cyclones every year that affect millions of people living near or within the coastal areas. When the magnitude of a disaster reaches a national level of response, the navies of both countries are mandated to augment other government agencies in support of disaster relief and response operations. Because time is of the essence, ships ready for sea near the affected areas are usually the immediate choice for deployment. We analyze the strongest tropical cyclones that devastated both countries and the resulting government responses to determine the most efficient and effective type of ship for Humanitarian Assistance and Disaster Relief (HADR) operations. The parameters we use in the analysis are the ships' current capabilities, the process to select ships for deployment, and the HADR policies of both countries, which result in the recognition of critical and non-critical ship's capabilities. The analysis also reveals the potential use of the amphibious capability for humanitarian logistics in coastal areas. This research may also serve as a guide for the United States Navy or other foreign navies in sending ships to any countries in East Asia and the Pacific region whenever international support is sought.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACS	Auxiliary Command Ship
AGB	Ice Breaker
AGS	Oceanographic Research Ship
AMS	Auxiliary Multipurpose Ship
AOE	Fast Combat Support Ship
AOS	Ocean Surveillance Ship
ARC	Cable Repairing Ship
ARV	Auxiliary Research Vessel
ASE	Experimental Ship
ASR	Submarine Rescue Ship
ASV	Auxiliary Support Vessel
ASY	Service Yacht
ATS	Training Support Ship
DD	Destroyer
DDG	Guided-Missile Destroyer
DDH	Helicopter Destroyer
DE	Destroyer Escort
DND	Department of National Defense
DR	Disaster Relief
DRRO	Disaster Response and Relief Operations
EM-DAT	Emergency Events Database
FDMA	Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications
FDR	Foreign Disaster Relief
FF	Frigate
FFM	Multi-purpose/Mine Frigate
FHA	Foreign Humanitarian Assistance
gpd	Gallons per Day
HA	Humanitarian Assistance
HADR	Humanitarian Assistance and Disaster Relief

ICS	Incident Command System
JAR	Japan's Area of Responsibility
JASDF	Japan Air Self-Defense Force
JCS	Joint Chiefs of Staff
JGSDF	Japan Ground Self-Defense Force
JMA	Japan Meteorological Agency
JMSDF	Japan Maritime Self-Defense Force
JSDF	Japan Self-Defense Force
JTF	Joint Task Force
kph	Kilometers per Hour
LC	Landing Craft
LCAC	Air Cushion Landing Craft
LCS	Landing Craft Ship
LCU	Utility Landing Craft
LD	Landing Dock Vessel
LST	Tank Landing Ship
LSV	Logistics Support Vessel
MOD	Ministry of Defense
MPAC	Multi-Purpose Attack Craft
MSO	Ocean Minesweeper
MST	Minesweeper Tender
NDRP	National Disaster Response Plan
NDRRMC	National Disaster Risk Reduction and Management Council
NGO	Non-Governmental Organization
OPB	Offshore Patrol Boat
PAGASA-DOST	Philippine Atmospheric, Geophysical, and Astronomical Services Administration – Department of Science and Technology
PAR	Philippine Area of Responsibility
PG	Patrol Gunboat (PN), Guided-Missile Patrol Boat (JMSDF)
PN	Philippine Navy
PS	Patrol Ship
PSA	Philippine Statistics Authority

PV	Patrol Vessel
RHIB	Rigid Hull Inflatable Boat
RSMC	Regional Specialized Meteorological Centre
SAF	Sealift Amphibious Force
SAR	Search and Rescue
SSHWS	Saffir-Simpson Hurricane Wind Scale
SSV	Strategic Sealift Vessel
STS	Severe Tropical Storm
STY	Super Typhoon
TC	Tropical Cyclone
TD	Tropical Depression
TS	Tropical Storm
TV	Training Ship
TY	Typhoon
USAID	United States Agency for International Development
USDOD	United States Department of Defense
USDOS	United States Department of State
USG	United States Government
WASAR	Water Search and Rescue
WHEC	Weather High Endurance Cutter
YB	Yard Bilge Barge
YDT	Yard Disposal Tender
YF	Yard Ferry
YG	Yard Gasoline Oiler
YL	Landing Craft Lighter
YO	Yard Oiler
YOT	Oil Tanker
YT	Yard Tugboat
YTE	Yard Training Education
YW	Yard Water Barge

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EXECUTIVE SUMMARY

In the area of humanitarian logistics, where time is of the essence, an immediate and effective response is needed to lessen the burden of the agony of the affected individuals and minimize the loss of lives. Sending the nearest ships to a disaster area without the necessary capabilities may not be an effective option for relief efforts. As such, in the deployment of an appropriate navy ship or combination of ships to the affected coastal areas after a strong typhoon (TY) strikes, decision-makers must consider the ships' capabilities essential to optimize the efficacy of response for humanitarian assistance and disaster relief (HADR) operations (Apte et al., 2013).

The frequent occurrences of tropical cyclones (TCs) in the Philippines and Japan, both located in the Typhoon Belt of the Pacific, that affect millions of people every year have motivated this research. On average in the last 20 years, 19 TCs entered the Philippine area of responsibility (PAR) each year, while 12 entered Japan's area of responsibility (JAR). These TCs are classified from tropical depression (TD) to TY and super typhoon (STY) (Philippine Atmospheric, Geophysical, and Astronomical Services Administration – Department of Science and Technology (PAGASA-DOST), 2021; Japan Meteorological Agency (JMA), 2022). When the magnitude of a TC reaches a national level of response, the navies of both countries are mandated to augment other government agencies in support of disaster relief (DR) and response operations. Navy ships are used to transport supplies, people, and equipment from the port of embarkation to the affected coastal areas.

The analyses of the strongest TCs that devastated both countries and the government responses to these disasters were found to be useful to identify the navy's role and the frequent missions of the navy ships in HADR operations. STY Haiyan (2013) and STY Goni (2020), which both recorded a maximum sustained wind speed of 315 kilometers per hour (kph), had devastated the Philippines and affected more than 16,000,000 and 2,000,000 individuals, respectively (PAGASA-DOST, 2021; National Disaster Risk Reduction and Management Council (NDRRMC), Government of the Philippines, 2013). In Japan, on the other hand, TY Wipha (2013) and TY Hagibis (2019), with sustained wind of 167 kph and 160 kph, had caused 40 and 118 deaths, respectively

(JMA, 2013; Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications (FDMA), 2019). Both the Philippines and Japan have three major roles and two main missions. The navies' roles include a main effort for water search and rescue (WASAR), a supporting effort for the logistics cluster, and a supporting effort for other clusters on a need basis. Similarly, the ships' missions are to conduct WASAR, provide transport platforms for the logistics cluster, and provide support to other HADR response clusters. These roles and missions lead to the identification of the ships' required capabilities in order to be efficient and effective.

Further, to determine the appropriate navy ship for HADR operations in the coastal areas after a TY or STY strike, suitable parameters were used to fit into the conceptual framework of analysis. These parameters include the ships' current capabilities, the process to select ships for deployment, and the HADR policies of both countries, which result in the recognition of critical and non-critical ships' capabilities (Greenfield & Ingram, 2011; Gastrock & Iturriaga, 2013; Apte et al., 2013; Moffat, 2014). Naval assets, specifically, ships with airlift capability, are frequently tasked as logistics platforms from the point of embarkation to the affected areas not easily accessible to commercial means of transportation. Navy ships to be deployed for HADR operation must have the critical capabilities, including the WASAR, vertical lift support, and medical support. On the other hand, the non-critical capabilities comprise fuel storage and dispensation, transit speed, hydrographic survey, salvage operations capability, and towing capability. The strategic sealift vessel (SSV) of the Philippine Navy (PN) and the tank landing ship (LST) and helicopter destroyer (DDH) of the Japan Maritime Self-Defense Force (JMSDF) possess all of these capabilities and are found to be the most appropriate navy ships in the current inventories of both countries (Janes, 2022).

Moreover, our in-depth analysis reveals the potential utilization of the Fleet Marine Force amphibious capability for comprehensive humanitarian logistics in the coastal areas. With the experience and capability of the amphibious force in beach landings for ship-to-shore movement and transport of relief goods, equipment, and personnel from the sea to the affected coastal areas, specifically, if the areas are inaccessible to any means except by the sea, relief efforts could be logistically feasible.

In conclusion, our research makes five contributions to those planning HADR operations in the PN and the JMSDF. First, we argue that the critical capabilities we identify should be the primary criteria when selecting ships. Second, we provide a table listing both critical and non-critical capabilities. Third, we argue that the role and mission of the navy in a particular disaster should be considered when deploying a mix of assets to respond to that disaster. Fourth, we argue that logistics and budgetary requirements should be forecasted in advance since TYs and STYs occur on a regular basis. Fifth, we provide information that can be useful to navies of other nations, responding to a request for support from the affected nation.

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I. INTRODUCTION

Situated in the Ring of Fire and the Typhoon Belt of the Pacific, the Philippines and Japan are prone to natural disasters like earthquakes, volcanic eruptions, tsunamis, monsoon rains, and tropical cyclones (TCs). As most of the population in both countries live in or near the coastal areas susceptible to typhoons (TYs), several government policies and disaster response and mitigation plans were formulated by both countries as countermeasures to save lives and reduce the effects on human suffering. Even though TCs occur annually, it is beneficial to note that the countermeasures against these disasters and the disaster relief (DR) and responses differ greatly in both countries (Philippine Disaster Risk Reduction and Management Act, 2010; Basic Act on Disaster Management, 2016).

The Philippine and Japanese national governments respond to a disaster that requires a nationwide level of response. The government efforts have fallen into an ad hoc response as well as the countermeasures for a wide range of disaster response and relief operations (DRRO), however. In particular, if the damages in the affected areas are enormous and the local disaster response units cannot perform their jobs because they are victims too, then the governments on a higher or broader level step in. Although the damages can be assessed to some extent after the disaster strikes, the information needed for an efficient response in a speedy manner is uncertain (Apte, 2009).

When data is not available, it is hard for the logistics professionals to estimate the number of supplies to procure, select the most appropriate transport platform to use, determine where to pre-position the assets and maritime platforms (Salmerón & Apte, 2010), and plan the duration of the deployment of navy ships and other capital equipment. In the selection of the appropriate navy ship or flotilla, decision-makers have limited tools and data on what type of ship or how many ships should be deployed for DRRO. Most of the time, planners and task commanders focus on capability, proximity to the mission area, and cost of ships' deployment (Apte et al., 2020) in the selection of navy ships for DRRO.

Additional tools and data could be used in humanitarian assistance and disaster relief (HADR) decision-making processes to ensure optimal utilization of government resources. Critical data during humanitarian assistance and response include (1) how many people will need help after the onslaught of a disaster and (2) how the government will select and deploy the national assets efficiently and effectively. Early forecasting of the number of affected people in the early stage of the TC could optimize the utilization of government resources. It could also minimize the manpower requirements, provide ease in the management of supplies, and minimize the total cost of humanitarian assistance and relief operations.

A. RESEARCH OBJECTIVES

This research examines how the navies of the Philippines and Japan should select the appropriate naval capability or the mix of naval capabilities that could efficiently and effectively respond to HADR operations. Also, the study investigates the factors that should influence the response of the decision-makers at the strategic and operational level of both navies in sending ships to the affected areas. For this purpose, we also study the current naval capabilities of both navies to understand if they are effective to conduct HADR operations following a sudden disaster such as TYs and super typhoons (STYs).

B. SCOPE AND METHODOLOGY

In this research, we analyze the selection for the deployment of navy ships of the Philippines and Japan and their different capabilities. There was prior research on the selection of navy ships for humanitarian efforts, particularly for the United States (U.S.) Navy ships, but the consideration was on the relief requirements (Apte et al., 2013). Likewise, we analyze the naval assets of both countries on how the current capabilities of their respective navies could fill in the HADR requirements at the national level of response. In addition, this research provides information for the international responders, specifically for the U.S. Navy, on what naval assets are critically required in case the naval capabilities of the affected country are not enough to respond to the nation's HADR requirements.

This research does not verify whether the provided tools can be applied to the navies of other countries, however. This is because the resources of each country are different, and there are differences in the way of thinking about disasters; therefore, more detailed research is required. Future research can develop into something that can be applied to the navies of other countries, based on the tools we provide in this research.

In addition, this research was based on the previous studies on humanitarian logistics in natural disasters, specifically on the assessment of the capabilities of the navy ships of the Philippines and Japan deployed for HADR operations after TC strikes in the coastal areas of both countries. The details are further discussed in the succeeding chapters. We develop a conceptual framework for applications for the Philippines and Japan to analyze the role of the navy in the national disaster plan and the required capabilities for the navy ships' tasks for HADR missions to determine the most appropriate ship for HADR operations in the coastal areas.

C. THESIS OVERVIEW

We briefly provide the background of disasters in the Philippines and Japan in Chapter II.

Then, we analyze previous research from various perspectives in Chapter III. Based on this, we derive our tools and parameters.

In Chapter IV, we describe and present the data that we use as the basis of analyses for this study. Furthermore, we identify the capabilities of the navy ships currently owned by the Philippines and Japan and visualize the ship capabilities of both countries based on the Likert scale presented in the previous research. We also develop a conceptual framework for determining the ships' capabilities for HADR operations in the coastal areas after a TC strike.

In Chapter V, we analyze relevant reports of the past TYs and STYs, determine the roles of the navies of the Philippines and Japan during natural disasters, and assess the capabilities of the navy ships of both countries required for HADR operations. We also analyze the participation of navy ships in the phases of the disaster.

In Chapter VI, we organize the results of our study and describe room for further research in the future. We also consider how our model can be used in an international framework for DRRO.

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II. BACKGROUND

A. DISASTER ENVIRONMENT

Globally, most natural disasters occur in Asia and the Pacific. Per Emergency Events Database (EM-DAT) data for global natural disasters from 2000 to 2020, there were 325 occurrences of natural disasters in the Philippines and 151 in Japan, which placed these countries in the top four and top seven, respectively, of the global rankings of disaster-prone countries. Of these occurrences, both nations had experienced more than 50 percent of storms or TCs in the past two decades that affected more than 125,000,000 people (Guha-Sapir et al., 2021).

The Philippines, an archipelagic country, is composed of 7,641 islands with 60 percent of its population of 109,000,000 living in or near the coastal areas that are the most vulnerable to TCs (Mapa, 2021). TY season has become the way of life for Filipinos. On average, 20 TCs ranging from tropical depression (TD) to STY entered the Philippine area of responsibility (PAR) each year over the last two decades and affected at least 122,100,000 people (National Disaster Risk Reduction and Management Council (NDRRMC), 2014b). The 2018 annual report of the Philippine Atmospheric, Geophysical, and Astronomical Services Administration-Department of Science and Technology (PAGASA-DOST) stated that a total of 21 TYs entered the PAR in 2018. These TYs combined for a lifespan of seven days and 10 hours and were inside the PAR for three days and a half hour. The path of TCs usually starts from the Pacific Ocean and enters the eastern seaboard or in the coastal areas of the country that traverse westward, northwestward, and north-northeastward going to Taiwan and Japan (Weather Division, PAGASA-DOST, 2020).

Japan, also an archipelagic country, is composed of more than 6,800 islands with approximately 80 percent of its population of 1,25,800,000 living near the coastal areas according to the Statistical Handbook of Japan 2021 (Statistics Bureau of Japan, 2021). Due to its climate condition and geographical location in the Pacific Rim, Japan experiences many disasters such as tsunamis, earthquakes, and TCs. An average of 11 out of 26 TCs that form in the northwestern Pacific enter Japan's area of responsibility (JAR) each year, of which three make landfall (Japan Meteorological Business Support Center, 2016). The 2019 report of the Japan Meteorological Agency (JMA), through the Regional Specialized Meteorological Centre (RSMC), stated that 29 TCs formed and three reached the level of TY including TY Hagibis.

Due to these natural phenomena and their geographical locations, both countries are exposed to a lot of natural disasters. In 2013, STY Haiyan (Yolanda), one of the strongest TCs ever recorded in history, hit the Philippines and claimed 6,300 lives, injured 28,688, and affected 16,078,181, while 1,062 are still reported missing (NDRRMC, 2013). Due to the magnitude of the devastation, the Philippines were overwhelmed despite the early mitigation efforts of the national government. Although the weather forecast was almost accurate, it surprised the nation as the number of affected individuals was not expected to be that high. Lessons were learned in STY Haiyan, and the international response was considered effective despite many limitations such as coordination failures with the local authorities and data gathering (Dy & Stephens, 2016).

In Japan, STY Haiyan did less damage than in the Philippines due to the weakening of this STY. The one that caused the most damage in recent years in Japan was TY Hagibis (2019). It traversed the Japanese archipelago for about a week and brought destruction to various parts of the country. Even a developed county like Japan, which has a more prepared disaster response and mitigation system than developing countries, did not escape the wrath of TY Hagibis. The total deaths were 99, the number of injured was 470, and the number of affected people was 390,470 (Guha-Sapir et al., 2021). Also, as this TY passed near the highly urbanized Tokyo, it blocked many logistics and transportation networks and had a great impact on people's lives.

B. CURRENT DISASTER RESPONSE AND OPERATIONS

Although TCs occur annually, countermeasures differ greatly from country to country. In this study, we compare the HADR in the Philippines and Japan in terms of the naval response after the disaster strikes. We look at the different political systems, lessons from past disaster experiences, and available HADR equipment and naval capabilities.

In the Philippines, given that disaster risk exists due to extreme weather vulnerability, the government has enacted many laws relevant to HADR. The most prominent is the Republic Act No. 10121, also known as the Philippine Disaster Risk Reduction and Management Act of 2010, which paved the way for the formulation of national HADR policies in the country. Among those policies are the National Disaster Response Plan (NDRP) for Hydro-Meteorological Hazards Version 2, a strategic plan of a whole-government and private sector approach to mitigate the risk and efficient response (NDRRMC, DSWD, OCD, 2016). The NDRP provides the level of responses for all water-related disasters from the national level down to the barangay level, which is the smallest form of government.

During the national-level response, the Armed Forces of the Philippines, through its major services, the Army, Air Force, and Navy, are tasked to support the HADR operations of the national government. These activities are conducted either by augmentation with other government agencies and non-government organizations or by directed activities through the chain of command. All military equipment and capital assets such as trucks, ships, and aircraft are expected to be available and ready to be deployed in the affected areas. The selection of the most appropriate asset for DRRO is at the discretion of the major service commanders or by the operational area commanders. With the limited naval assets of the Philippine Navy (PN), deployment to the affected areas mainly relies on the proximity and availability of ships. All available PN assets are on standby status and ready to be deployed upon receipt of the order with greater consideration to ships' capacities than the capabilities since most of the mission is based on the transport of relief goods, HADR equipment, and personnel.

In Japan, on the other hand, responders differ greatly depending on the degree of damage caused by the disaster. Reflecting on the TY Vera that caused great damage in 1959, the Japanese national government enacted the Basic Act on Disaster Management (Basic Act on Disaster Management, 2016). The local government will play a central role in disaster countermeasures. If the scale of the disaster will be large and widespread, the Japanese national government will take the initiative upon approval by the cabinet of the national government. In recent years, the number of large-scale natural disasters has increased, and the national government is increasingly taking the initiative based on the Basic Act on Disaster Management (Basic Act on Disaster Management, 2016). Furthermore, in the reconstruction phase, if the amount of damage exceeds a certain amount of tax revenue of the local government, restoration support may be financially supported by the designation of the national government (Act on Special Financial Support to Deal with the Designated Disaster of Extreme Severity, 2016). In this way, the national government is trying to take measures against TYs from various angles in cooperation with local governments.

The Japan Self-Defense Force (JSDF) plays an extremely important role in disaster countermeasures in Japan. The Self-Defense Forces Act stipulates disaster dispatch as the main mission of the JSDF, and they engage in many activities (Self-Defense Forces Act, 2019). In most cases, the affected people from disasters are mainly supported by nearby troops of the Japan Ground Self-Defense Force (JGSDF). In addition, three service branches, the JGSDF, the Japan Maritime Self-Defense Force (JMSDF), and the Japan Air Self-Defense Force (JASDF), carry out search and rescue (SAR) operations. The mission of the JMSDF in disasters, however, is not very wide. SAR operations are the main mission, but other missions are rarely imposed unless the scale of the disaster is extremely large. Various training is still actively carried out as an important task to protect the lives of the people.

While the governments and the militaries of the Philippines and Japan are mandated to engage in disaster response, the United States Government (USG) remains committed to reaching out to help large-scale international disasters, specifically if the host nation is overwhelmed and HADR equipment is crucially needed. The United States Agency for International Development (USAID) is the main lead of the USG for foreign disaster response, while the United States Department of Defense (USDOD) acts to support the civilian organizations when requested for the humanitarian efforts (USAID - BHA, 2020). When the magnitude of the disaster reaches the international level of response, the relevant information is crucial to the speedy delivery of relief items in the right place, at the right time, with optimal utilization of resources (Apte, 2011).

III. LITERATURE REVIEW

A. NATURAL DISASTERS IN ASIA AND THE PACIFIC

Various forms of natural disasters such as earthquakes, floods, volcanic eruptions, TCs, and heavy rains among others are global phenomena that directly affect human lives. Some parts of the globe experience fewer occurrences, while other parts are more susceptible to natural disasters. Also, the occurrences of natural disasters in Asia and the Pacific region are higher than in other areas of the world (Guha-Sapir et al., 2021). As a consequence, many people are affected in this region, and the burden of economic losses is unsurmountable. TCs, TYs, and other hydro-meteorological phenomena are some of the deadliest and most common types of natural disasters. TYs in this area travel along the rim of the Pacific Ocean from near the equator to the North Pacific and pose a threat to many countries in this region. Among these countries are the Philippines and Japan, which are located on the TY path in this area.

Natural disasters are being recognized as a major global issue and threat to humankind (United Nations, 2015) that require partnerships and cooperation among nations. Locally or globally, governments need to respond to all kinds of natural disasters to alleviate human suffering and recover from damages to property and infrastructures. In the United States, the United States Department of State (USDOS) and USAID are proactively tackling this issue with allied countries and other non-governmental organizations (NGOs). In times of DRRO, cooperation with various government agencies is important as a cross-agency collaboration (USDOS & USAID, 2018), which includes the USDOD and the military as well. The participation and engagement of the USDOD and the military are effective methods against natural disasters because of their peculiar capabilities. These functions will be verified in the later chapter, but it is necessary to further focus on playing a part in coping with natural disasters by utilizing this unique capability. Therefore, not only the U.S. but also other countries need to tackle this issue, and there is a great deal of opportunity for military activity.

Humanitarian assistance of the responders, particularly of the NGOs, varies with the phase and category of the disaster. Based on location and time, Apte (2009) divides the natural disasters into four categories and describes each characteristic—localized and slow-onset, dispersed and slow-onset, localized and sudden-onset, and dispersed and sudden-onset, as shown in Figure 1. A slow-onset disaster gives more time for preparation than a sudden disaster, while the location is vital for risk estimation.

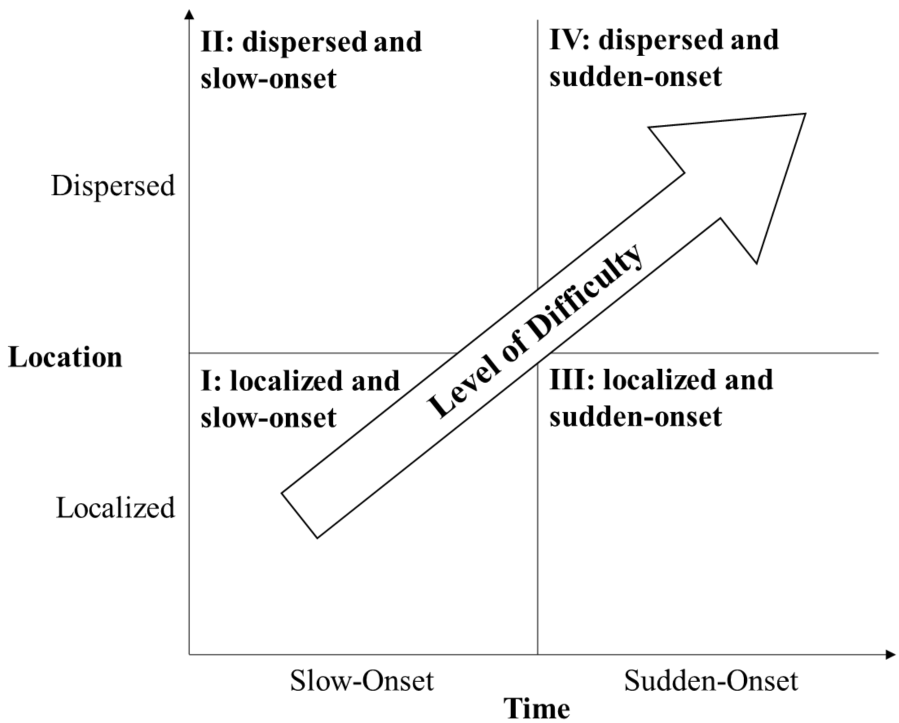

Figure 1. Classification of Disasters. Source: Apte (2009). This figure classifies the level of difficulty and challenge of dealing with and responding to a disaster. The time of onset is set on the horizontal axis, and the size of the location is set on the vertical axis, which shows that dispersed and sudden-onset disaster is the most challenging to handle.

B. DISASTER LIFE CYCLE

Even if one natural disaster occurs, it can be divided into three phases: preparedness, response, and recovery (Lee & Zbinden, 2003; Apte, 2009). Apte (2009) states that humanitarian logistics can be discussed from the same perspective as analyzing the supply chain, as shown in Figure 2. Being prepared before the disaster strikes takes considerable effort and a long-time preparation. Response after it strikes, if one is prepared, takes a shorter time. Recovery, however, takes the longest time.

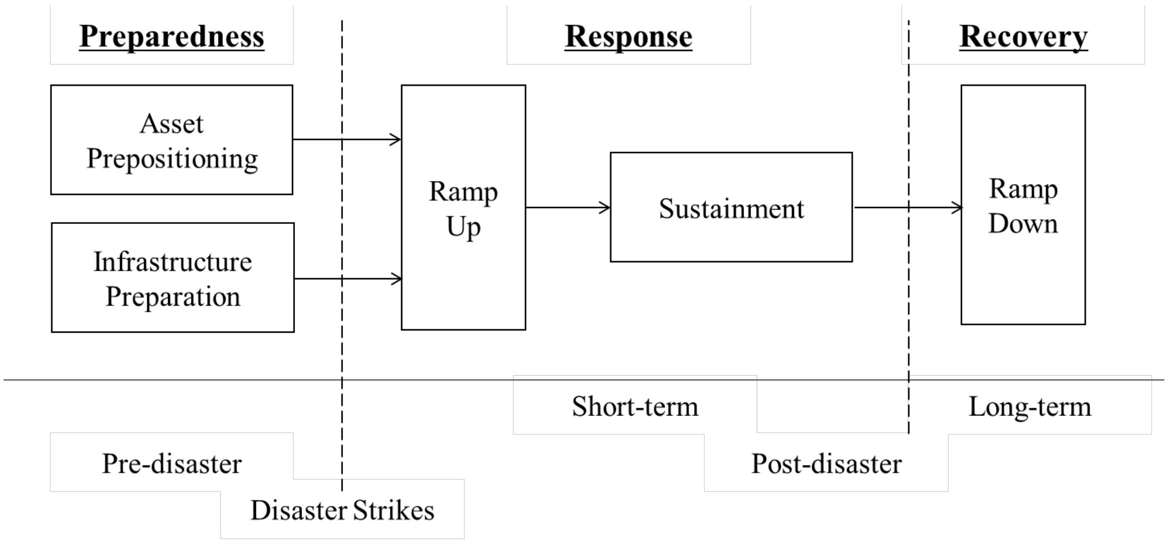

Figure 2. Disaster Life Cycle. Source: Apte (2009). This figure shows the phases of efforts for one disaster cycle divided into three stages: the preparedness phase before a disaster strikes, the response phase immediately after a disaster, and the recovery phase for the long-term recovery of the disaster area.

The first stage of the disaster life cycle needs to be very strategic. At this stage, when no disaster has occurred, it is necessary to estimate the extent of the disaster, preposition the necessary supplies and equipment, and prepare the infrastructure. The budget dictates the range and scope of preparation, but the budget is always finite and the response cost for natural disasters is proportionate to the number of affected people and the damage to properties and infrastructures. The amount of budget and the level of risk against unpredictable natural disasters is an important decision in the preparedness stage.

When a natural disaster occurs, relief supplies and donations are gathered from various organizations and concerned individuals. In addition to supplies, funding will increase dramatically in this phase (Gustavsson, 2003). In some cases, necessary supplies may be urgently procured, or in other cases, stock supplies may be delivered to the affected area immediately. In the response stage, an appropriate distribution process and acquisition management are extremely important factors.

Going beyond the phase immediately after such a disaster, in the recovery stage, it is difficult to divide the timeline. As the need for support diminishes, however, the affected people gradually return to their normal lives. Also, collecting lessons learned and preparing for the next disaster is an important point at this stage.

In addition, many logistics activities are required at each stage such as preparation of the necessary supplies, minimizing the risks, and collection in the optimum location. This is particularly helpful in the event of a disaster. The supplies that have been accumulated in advance will be delivered to the required locations, while the supplies that need safety stocks will be procured in no haste.

C. REQUIREMENTS FOR HADR OPERATIONS

The HADR operation includes relief activities for disasters and support activities at the time of reconstruction, but it has two different implications: humanitarian assistance (HA) and DR. As various previous studies have shown, DR includes immediate activities after disaster strikes and HA is a long-term support (Kovács & Spens, 2007; Apte, 2009).

The USDOD defines HA and DR in Joint Publication 3-29 as follows:

> Foreign humanitarian assistance - Department of Defense activities conducted outside the United States and its territories to directly relieve or reduce human suffering, disease, hunger, or privation. Also called FHA. (Joint Chiefs of Staff (JCS), 2019, GL-7)
>
> Foreign disaster relief - Assistance that can be used immediately to alleviate the suffering of foreign disaster victims that normally includes services and commodities, as well as the rescue and evacuation of victims; the provision and transportation of food, water, clothing, medicines, beds, bedding, and temporary shelter; the furnishing of medical equipment and medical and technical personnel; and making repairs to essential services. Also called FDR. (JCS, 2019, GL-7)

As Apte (2009) points out, it is important to know the needs of the affected people for the responders to support the relief activities, but this is extremely challenging. As defined above, various supplies are needed, but the supplies vary depending on the individual, region, and locally available supplies. In addition, relief supplies are gathered from all over the country or from all over the world to support this region. It is necessary to make effective use of these, but these relief supplies are not based on the needs of the affected people. It is difficult to operate in such a chaotic situation.

Moreover, in the event of a disaster, it is essential to take immediate and prompt action. Kovacs and Spens (2007) state that many disasters are characterized by the need for a swift response. Therefore, in the previous studies, several elements are necessary for the prompt response, such as supply chain construction and collaboration and coordination between organizations and countries (Kovacs & Spens, 2007; Apte, 2009).

D. RESOURCE SELECTION

Resource selection primarily depends on the available resources that the country could readily use. Assets and equipment are crucial for HADR activities because the affected country could request allied countries when it is difficult to handle the disaster on its own. Generally, the optimal solution differs depending on the country or region and the resources possessed. In this research, we intend to focus on the Philippines and Japan, as they have been extensively studied in the context of the U.S. Navy. For instance, Apte et al. have derived optimal modeling based on the track record of various HADR operations of the U.S. Navy (Apte et al., 2013, 2020; Apte & Yoho, 2017, 2018).

The resources possessed by the U.S. Navy and the navies of other countries are significantly different. As Gangcuangco et al. (2020) note the usefulness of the Littoral Combat Ship and Expeditionary Fast Transport in HADR operations, the U.S. Navy is considering a number of resource selections. There are, however, few studies in other countries.

Apte et al. (2013) analyzed resources based on the parameters of Table 1. They use the Likert Scale to subdivide the capabilities required for HADR operations and provide a way to derive disaster-adapted resources and combinations. In addition, Apte and Yoho (2014) analyze the nature of the mission and classifies this parameter into critical and non-critical, as shown in Table 2.

Table 1. Capacity Parameter Definitions for HADR Mission. Source: Apte et al. (2013).

Parameter		Rating	Capacity Rating Definition
Aircraft support		○	No embarked helo; unable to support helicopter operations
		◑	Single helo embarked; able to support the 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/offload cargo and store amphibious vehicles
Search and Rescue (SAR)		○	No embarked helo; unable to efficiently conduct SAR missions
		◑	Single helo embarked with communication equipment and night vision
		●	Multiple helos embarked with communication equipment and night vision
Dry goods storage Refrigerated goods storage	Cargo Capacity	○	No ability to store goods beyond current ship crew's use
Freshwater storage Roll On Roll Off	Cargo Capacity	◑	Ability to store supplies beyond ship crew's use
Fuel storage & dispensation Self-sufficient	Cargo Capacity	●	Ability to store and transfer large quantities 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, the shallow draft vessel with the ability to transport 30+ personnel per voyage
Freshwater production		○	No ability to produce fresh water beyond shipboard usage
		◑	Ability to produce and transfer >2,000 gallons per day (gpd) beyond shipboard usage

		Capacity Rating Definition
	●	Able to produce and transfer >5,000 gpd beyond shipboard usage
Personnel support	○	Low crew size with minimal ability to support HADR mission (<50 personnel)
	◑	Medium size crew which can support HADR mission (51-200 personnel)
	●	Large crew with the ability to support HADR mission (>200 personnel)
Berthing capacity	○	Little to no excess berthing or facilities (<30 racks)
	◑	Some excess berthing and facilities (31-50 racks)
	●	A large number of excess berthing and facilities (>50 racks)
Medical support	○	No ability to conduct inpatient medical treatment; 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
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 to include soundings and chart development
	●	Able to conduct hydrographic surveying, sounding, and chart development
Salvage Ops	○	No ability to conduct salvage operations
	◑	Some ability to conduct lift and salvage operations in shallow waters
	●	Able to conduct heavy lift and deep-water salvage operations
Towing	○	No ability to conduct towing operations
	◑	Ability to conduct emergency towing operations

		Capacity Rating Definition
	•	Designed to conduct push, pull, or alongside towing operations

These 18 parameters indicate the needed capabilities in the HADR operation, which are also the primary considerations of this research. Each is evaluated by the Likert scale into three categories: fully equipped (fully shaded), partially equipped (half shaded), and not equipped (not shaded).

Table 2. Critical and Non-critical HADR Mission Requests. Source: Apte and Yoho (2014).

Critical Mission Capabilities		Non-Critical Mission Capabilities
Aircraft support capability		Transit speed
Amphibious Landing Craft support		Hydrographic survey
Search and Rescue (SAR)		Salvage operations
Cargo Capacity	Towing	Towing capability
	Refrigerated goods storage	
	Fresh water storage	
	Roll On Roll Off (RORO)	
	Fuel storage & dispensation	
	Self-sufficient; no need for external cranes	
Personal transfer		
Fresh water production		
Personnel support for cleanup and recovery efforts		
Berthing capacity		
Medical support		

The parameters in Table 1 are divided into critical and non-critical based on past HADR missions of the U.S. Navy ships. In this research, however, while applying this concept, we derive a slightly different division based on the actual cases of the Philippines and Japan.

E. VERTICAL LIFT CAPABILITY

The previous section outlined the importance of various parameters, and many researchers have pointed out the importance of vertical lift capability (Apte et al., 2013; Apte & Yoho, 2014). Chirgwin and Katakura (2021) tried to derive the optimal combination of various vertical lift platforms by performing simulations and detailed analyses in terms of both cost and capacity in HADR operations. Vertical lifts have great potential as infrastructures such as roads and harbors are damaged by disasters.

IV. DATA AND METHOD OF RESEARCH

In this chapter, we present the relevant data, the data sources, and the framework of analysis. First, the TC's data were gathered, both from international and local natural disaster databases, to support the need for research for HADR operations. Second, TC classification of the different countries was included to recognize the similarities and differences of TC intensities and categories used in the U.S., Japan, and the Philippines. Third, the HADR capabilities of the PN and the JMSDF were identified based on the description of the previous studies to standardize the navy HADR terminologies (Greenfield & Ingram, 2011; Apte et al., 2013; Gastrock & Iturriaga, 2013; Moffat, 2014; Gangcuangco et al., 2020). Fourth, we formulated a conceptual framework in the analysis of the previous TYs and STYs that significantly hit both countries to determine what naval assets are the most appropriate for HADR operations in the coastal areas after the TC strikes.

A. TYPHOON HISTORY FROM INTERNATIONAL AND LOCAL DISASTER DATABASES

Occurrences of TCs have increased continually in the last 50 years. Data gathered from the EM-DAT, shown in Figure 3, indicates an average of 24 percent increase in occurrences every 10 years over the last five decades globally. This was computed by first taking the increase per decade, then calculating the average of the increases. A 29 percent increase from 1981 to 1990 was recorded as compared to the previous decade, 26 percent growth in the 1990s versus the 1980s, 31 percent jump in the 2000s from the 1990s, and 11 percent rise in 2011s from the 2000s. Though there was significant slack in the pace of increase in the last decade, still the occurrences of TCs cannot be ignored. The storm is the general term used by EM-DAT, which is synonymous with TC use in the Philippines and TY in Japan, respectively. Further, for the past 20 years (2001–2020), 162 TCs were recorded in the Philippines and 78 TYs in Japan affected more than 122,000,000 people (Guha-Sapir et al., 2021).

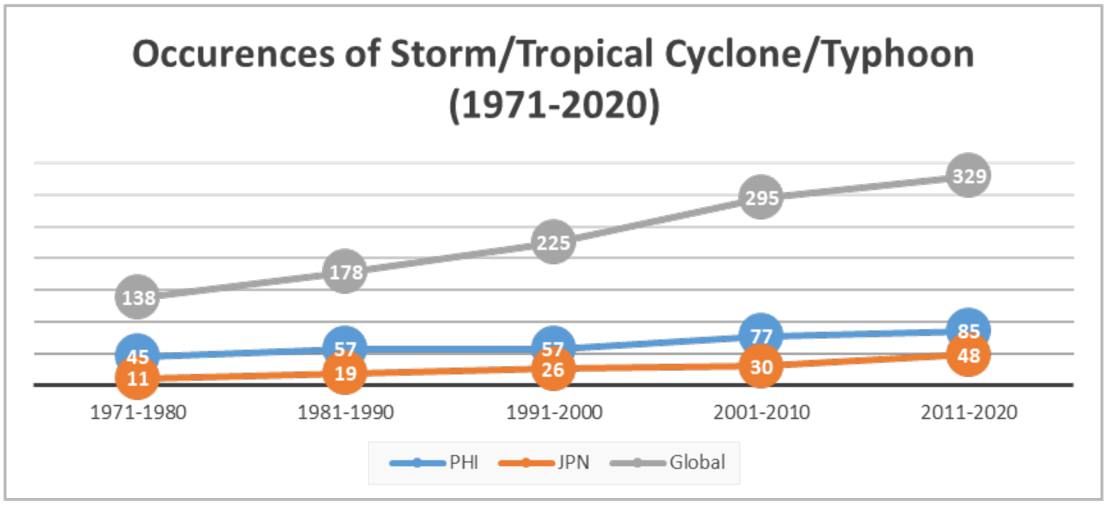

Figure 3. Occurrences of Storm/TC/TY, 1971–2020 (Global, the Philippines, Japan). Source: Guha-Sapir et al. (2021). The 50-year data from the international disaster database (EM-DAT) shows that the occurrences of storms, TCs, and TYs are on the rise worldwide. The Philippines and Japan are among the countries in East Asia and the Pacific that are naturally exposed to these threats every year.

On the local meteorological-hydrological database, TC data from the PAGASA-DOST, a national meteorological and hydrological agency, shows that an annual average of 19 TCs entered the PAR while seven landfalls were recorded from 2001 to 2020 (PAGASA-DOST, 2021). For the past two decades, 65 out of 183 TCs from 2001 to 2010 and 66 out of 194 TCs from 2011 to 2020 traversing the Philippines were classified from TD to STY (Figure 4).

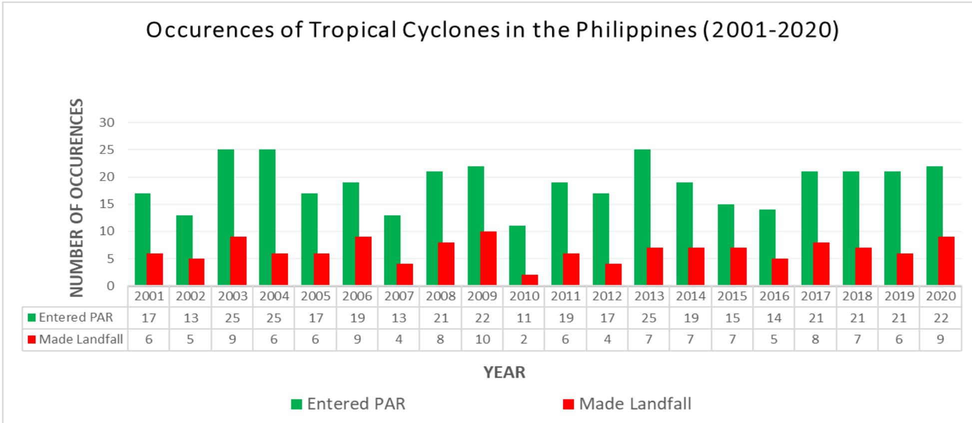

Figure 4. Occurrences of TCs in the Philippines (2001–2020). Source: PAGASA-DOST (2021). The PAGASA-DOST, a national weather monitoring agency in the Philippines, shows the actual occurrences of TCs in the Philippines from 2001 to 2020. On average, 19 TC enter the PAR and seven make landfall every year.

The JMA, on the other hand, recorded an annual average of 12 TYs that had approached JAR while three landed from 2001 to 2020 (Figure 5) (JMA, 2022). Unfortunately, although TY data was available, the TC data was not available in the database of JMA.

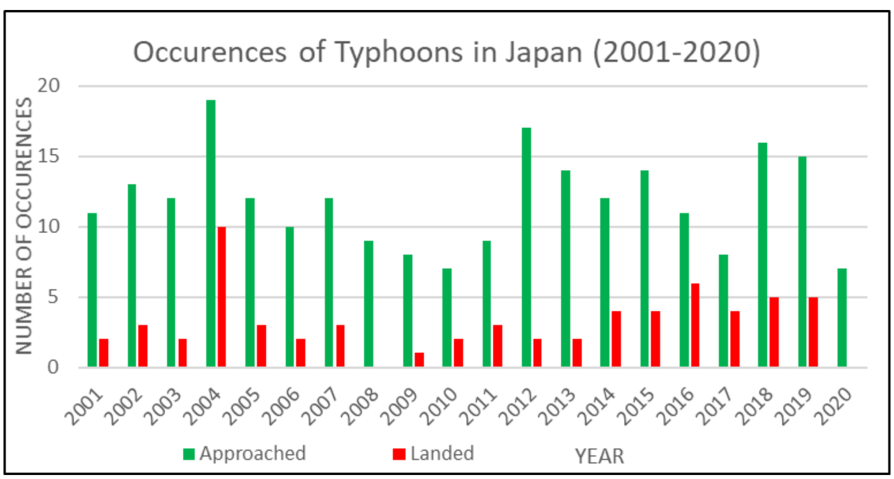

Figure 5. Occurrences of TYs in Japan (2001–2020). Source: JMA (2022). The national weather agency in Japan shows the actual occurrences of TYs in Japan from 2001 to 2020. Although it varies from year to year, Japan continues to be exposed to the threat of TYs every year. On average, 12 TYs approach JMA and three make landfall every year.

As we show, the international and local data sources had some discrepancies in the disaster counts. For example, in the EM-DAT database, from 2001 to 2010 and 2011 to 2020, 77 and 85 TCs occurred in the Philippines, while 30 and 45 TYs happened in Japan, respectively. In comparison with the local meteorological data of the Philippines and Japan, PAGASA-DOST recorded 183 and 194 TCs in the same decades, while JMA logged 113 and 123 TYs. Possible reasons for discrepancies could be the overlapping areas of responsibility between adjacent countries and the manner of data collection. This research, however, will not tackle those discrepancies but only add information about the international and local disaster databases, specifically TCs.

The Philippines and Japan have different weather boundaries or areas of responsibility defined by the country's weather agency. For instance, the PAR is locally set by PAGASA-DOST to define the boundaries in the Philippines and adjacent areas for the issuance of weather disturbance warning information. It comprises some parts of Palau in the East, Taiwan in the North, the northern tip of Borneo in the South, and the West Philippine Sea in the West, wherein the PAGASA-DOST monitors the formation, movement, and track of TCs. Similarly, JMA also has its own areas of responsibility. According to its statistical data, it defines an approach as when a TY enters within 300 km of the Japanese coast and landfall as when a TY crosses over Japan's landmass. Although the criteria for counting TY or TC differ in each country, they are also not the focus of this research, but to show and familiarize with the similarities and differences of the terminologies used by the two weather agencies such as entered, approached, and landed.

B. CLASSIFICATION OF TROPICAL CYCLONES

Classification of TCs varies from country to country. The Philippines has adopted the classification listed in Table 3 ranging from TD to STY with sustained wind from 61 kilometers per hour (kph) to more than 220 kph (PAGASA-DOST, 2021). PAGASA-DOST has been using this classification since 2015 to differentiate the degree of intensity of TC based on wind speed.

Table 3. Classification of TCs in the Philippines. Source: PAGASA-DOST (2021).

Classification	Wind Speed (kph)
Tropical Depression (TD)	Up to 61 kph
Tropical Storm (TS)	62–88 kph
Severe Tropical Storm (STS)	89–117 kph
Typhoon (TY)	118–220 kph
Super Typhoon (STY)	More than 220 kph

The Philippines' national weather agency, PAGASA-DOST, classifies TCs into five categories based on wind speed—TD, TS, STS, TY, and STY. This classification differs from the classification of Japan and the United States.

On the other hand, JMA uses three types of measurement properly according to various uses: category of tropical storms (TSs), size of TYs, and strength of TYs (JMA, 2022). The categories are divided into three according to the wind speed, as shown in Table 4.

Table 4. Classification of TCs in Japan. Source: JMA (2022).

Category	Maximum Wind Speed
TS (Tropical Storm)	61.2–90.0 kph
STS (Severe Tropical Storm)	90.0–118.8 kph
TY (Typhoon)	>118.8 kph

Unlike the Philippines, Japan's national weather agency, JMA, classifies TCs into only three categories based on wind speed—TS, STS, and TY.

In addition, the size of the TY is determined based on the radius of the region where the wind speed is 54 kph or more due to the TY, as shown in Table 5 (JMA, 2022). If this radius is asymmetric, the average value is taken.

Table 5. Size of TYs in Japan. Source: JMA (2022).

Size	The radius of >54 kph
(No description)	<500 km
Big	500–800 km
Extremely big	>800 km

JMA further classifies TY in terms of size and coverage—big TY and extremely big TY.

The strength of the TY, measured through the wind speed, is commonly used in Japan in classification by categories (JMA, 2022). It is an important factor to predict how much damage the TY can cause and a factor to consider for evacuation planning (Table 6).

Table 6. Strength of TYs in Japan. Source: JMA (2022).

Strength	Maximum Wind Speed
(No description)	<118.8 kph
Strong	118.8–158.4 kph
Very strong	158.4–194.4 kph
Furious	>194.4 kph

JMA also classifies the intensity of TY in terms of strength and wind speed—strong, very strong, and furious.

The Saffir-Simpson Hurricane Wind Scale (SSHWS), the globally accepted scale for TC classification, is used in this research (Table 7). Widely recognized worldwide, the SSHWS is useful in comparing the different TC classifications used by the Philippines, Japan, and the U.S. The Joint Typhoon Warning Center also uses this scale. It is extremely practical when considering joint operations and multilateral coordination (National Hurricane Center and Central Pacific Hurricane Center, 2021). On the other hand, the World Meteorological Organization does not recommend using this scale because the wind speeds of TYs and cyclones do not match this SSHWS. Because this study does not focus on the pros and cons of the scale, however, we will use it as the internationally accepted scale for the convenience of our analysis.

Using the SSHWS has two main advantages in this research. First, this scale allows side-by-side comparisons of national data, facilitating analysis by category. This makes it possible to analyze from the same point of view, regardless of the scales of the Philippines and Japan. Second, this scale can provide a common scale when applying our analysis to countries other than the Philippines, Japan, and the U.S. Therefore, although not covered in this study, it will be easier to apply in future studies.

Table 7. The SSHWS. Source: National Hurricane Center and Central Pacific Hurricane Center (2021).

Category	Sustained Winds
1	119–153 kph
2	154–177 kph
3	178–208 kph
4	209–251 kph
5	>251 kph

The U.S. uses the SSHWS in classifying the categories of the storm (hurricane) into five categories based on sustained wind strength. This classification differs from the TC classification of the Philippines and Japan. For standardization purposes, however, the SSHWS was adapted in this research.

Classification or categorization of TC or TY intensities differ in the Philippines, Japan, and the U.S. For instance, JMA has a TS as its first category in Japan with a maximum wind speed of 61.2 kph to 90 kph, while PAGASA-DOST uses TS as the second category, next only to a TD, with the wind speed from 62 kph to 88 kph. On the SSHWS, on the other hand, the hurricane classification starts with 119 kph to 153 kph as category 1. This range of wind speed is already within the TY category in the Philippines and Japan—118 kph to 220 kph in the Philippines and more than 118.8 kph in Japan. Though the three scales have a different range of wind speed in the TY classification, it is worth noting that the range of wind speed in the TY category has few discrepancies. Intensity classification is a crucial factor for humanitarian logistics since HADR planning and the scope of response depend on it. While the pros and cons of the different TC classifications used by the different weather agencies are not covered in this study, the tables of TC classifications could be beneficial in future research.

C. IDENTIFICATION OF THE CURRENT NAVAL CAPABILITIES FOR HADR

1. Development of the Previous Studies

This research has adopted but modified the Capacity Parameter Definition table of the previous research for the identification of the current HADR capabilities of both navies of the Philippines and Japan to standardize the capability rating definition used by the U.S. Navy—as discussed earlier in the literature review—in the selection of maritime capabilities shown in Table 8 (Greenfield & Ingram, 2011; Apte et al., 2013; Moffat, 2014). First, we modified the HADR capability rating of the Likert scale used by Greenfield and Ingram (2011) into the numerical scale as adapted by Moffat (2014) to easily compare the current type of ships with the HADR capabilities, but we do not compare the superiority of the parameters. This is because comparing the capabilities of the PN, the JMSDF, and the U.S Navy alone is not sufficient, and the proportion of capabilities required by regions and countries may differ.

Second, we modified the SAR parameter defined by Greenfield and Ingram (2011). Since the SAR capability for sea surface is extremely important for a navy's HADR performance, the parameter name was changed. The SAR, in this research, includes not only a helicopter but also rigid hull inflatable boat (RHIB) utilization. Also, the SAR parameter used by the JMSDF and the U.S. Navy is synonymous with the water search and rescue (WASAR) used by the PN. The PN is using this term to differentiate the capability from other government agencies and to specifically define its scope and area of operations.

Table 8. Capability Parameter Definition for HADR Operations. Adapted from Greenfield and Ingram (2011), Apte et al. (2013), Gastrock and Iturriaga (2013), Moffat (2014), and Gangcuangco et al. (2020).

Parameter		Rating	Capacity Rating Definition
Aircraft support (Vertical Lift)		1	No embarked helo; unable to support helicopter operations
		2	Single helo embarked; able to support the majority of helo platforms
		3	Multiple helos embarked; able to sustain multiple flight operations simultaneously
Landing Craft support		1	No ability to support landing craft
		2	Some ability to support landing craft
		3	Landing craft embarked; able to load/offload cargo and store amphibious vehicles
Water Search and Rescue (WASAR)		1	No embarked helo or RHIB; unable to efficiently conduct SAR missions
		2	Single embarked helo or RHIB with communication equipment and night navigation
		3	At least one embarked helo and one RHIB with communication equipment and night navigation capability
Dry goods storage Refrigerated goods	Cargo Capacity	1	No ability to store goods beyond the ship crew's use
Freshwater storage Roll On Roll Off		2	Ability to store supplies beyond ship crew's use
Fuel storage & dispensation Self Sufficient in Cargo		3	Ability to store and transfer large quantities of supplies
Personnel transfer		1	No ability to support personnel transfer; the slow-speed vessel with a deep draft
		2	Ability to support personnel transfer for 15+ personnel
		3	High speed, a shallow draft vessel with the ability to transport 30+ personnel per voyage
Freshwater production		1	No ability to produce fresh water beyond shipboard usage
		2	Ability to produce and transfer >2,000 gallons per day (gpd) beyond shipboard usage
		3	Able to produce and transfer >5,000 gpd beyond shipboard usage

		Capacity Rating Definition
Personnel support	1	Low crew size with minimal ability to support HADR mission (<50 personnel)
	2	Medium size crew that can support HADR mission (51–200 personnel)
	3	Large crew with the ability to support HADR mission (>200 personnel)
Berthing capacity	1	Little to no excess berthing or facilities (<30 racks)
	2	Some excess berthing and facilities (31–50 racks)
	3	A large amount of excess berthing and facilities (>50 racks)
Medical support	1	No ability to conduct inpatient medical treatment; no medical officer embarked
	2	Some medical support onboard; ability to support minor medical procedures
	3	Medical officer embarked; ability to perform surgeries and hold several patients
Transit speed	1	0–18 knots max speed
	2	19–24 knots max speed
	3	25+ knots max speed
Hydrographic survey	1	No ability to conduct hydrographic surveys
	2	Some ability to conduct hydrographic surveys to include soundings and chart development
	3	Able to conduct hydrographic surveying, sounding, and chart development
Salvage Ops	1	No ability to conduct salvage operations
	2	Some ability to conduct lift and salvage operations in shallow waters
	3	Able to conduct heavy lift and deep-water salvage operations
Towing	1	No ability to conduct towing operations
	2	Ability to conduct emergency towing operations
	3	Designed to conduct push, pull, or alongside towing operations

These 18 parameters, adapted from previous research, are the same capabilities used in the evaluation of the PN and the JMSDF ships for capability comparison to standardize the terminologies for the ships' HADR capabilities. Each parameter is evaluated by the numerical scale into three categories: fully equipped (3), partially equipped (2), and not equipped (1), and the capabilities possessed by each ship are visualized.

2. Application to the Philippine Navy and Japan Maritime Self-Defense Force

The PN, like most other navies, is comprised of Fleet and Marine forces. Each of these forces has distinct HADR capabilities, but during DRRO, the two organizations work hand in hand as the Fleet-Marine Force. Among the current PN capabilities for HADR operations are WASAR, sealift and transport, ship-to-shore movement, limited vertical lift, and sea-based logistics. Most tasks for PN-directed HADR operations are delegated to the Sealift Amphibious Force (SAF), one of the major units of the Philippine Fleet, due to its unique capabilities as compared with other Fleet Forces. SAF floating assets, also capable of logistics support at sea and amphibious support, include landing dock vessels (LDs), logistics support vessels (LSVs), tank landing ships (LSTs), and auxiliary vessels such as fuel tender and landing crafts (LCs). In addition, the Naval Combat Engineering Brigade has special capabilities such as road clearing and other engineering competencies that could be augmented by the Fleet-Marine Force whenever deemed necessary. Further, Table 9 evaluates the type-ship of the PN as compared with the HADR capabilities. Among the ships owned by the PN, the LD, LSV, and LST can be highly regarded with many disaster response capabilities that can be effectively used for HADR operations.

Table 9. PN Ships to Capability Comparison. Adapted from Greenfield and Ingram (2011); Apte et al. (2013), Gastrock and Iturriaga (2013), Moffat (2014), and Gangcuangco et al. (2020).

HADR Capabilities	PN Type Ship									
	FF	WHEC	PV	LD	LSV	LST	LC	ACS	ASV	ARV
Aircraft support	2	2	1	3	2	2	1	1	1	1
Landing Craft support	1	1	1	3	2	1	3	1	1	1
Water Search and Rescue	2	2	2	3	1	1	1	1	1	1
Dry goods storage	3	3	2	3	3	2	2	2	2	2
Refrigerated goods storage	3	3	2	3	3	2	2	2	2	2
Fresh water storage/dispensation	3	3	3	3	3	2	2	2	2	2
Roll On Roll Off	1	1	1	3	3	3	3	1	1	1
Fuel storage/dispensation	3	3	3	3	3	3	3	3	3	3
Self Sufficient	3	3	3	3	3	3	3	3	3	3
Personnel transfer	3	2	2	3	2	2	2	2	2	2
Freshwater Production	3	3	3	3	2	1	1	2	1	3
Personnel support	1	1	1	3	2	2	1	2	1	2
Berthing capacity	2	2	2	3	3	3	3	2	2	2
Medical support	2	2	2	3	2	1	1	3	2	2
Transit speed	3	2	2	2	1	1	1	1	1	2

Hydrographic survey	2	2	2	2	2	1	1	1	1	3
Salvage Operations	1	1	1	1	1	1	1	1	1	1
Towing	2	2	2	2	2	2	2	1	1	2

HADR Capabilities	PN Type Ship			
	LCS	PG	MPAC	OPB
Aircraft support	1	1	1	1
Landing Craft support	3	1	1	1
Water Search and Rescue	2	1	2	1
Dry goods storage	2	2	1	1
Refrigerated goods storage	2	2	1	1
Fresh water storage/dispensation	2	2	1	1
Roll On Roll Off	3	1	1	1
Fuel storage/dispensation	3	2	2	1
Self Sufficient	3	2	2	2
Personnel transfer	2	2	1	1
Freshwater Production	1	1	1	1
Personnel support	1	1	1	1
Berthing capacity	2	1	1	1
Medical support	1	1	1	1
Transit speed	1	2	3	3
Hydrographic survey	1	1	1	1
Salvage Operations	1	1	1	1
Towing	2	1	1	1

The parameters set in Table 8, measured in the Likert Scale, were applied to the current inventory of PN ships to determine which type of ship is most capable of HADR operations.

On the other hand, the JSDF is different from other countries' military. The JSDF, in particular, does not have a Marine Corps, and many of its functions are substituted by the JGSDF. In the event of disaster response, it is rare for the JMSDF to operate alone—a Joint Task Force (JTF) will be formed, and the JGSDF, JMSDF, and JASDF will operate in a unified manner under a unified commander. Among them, the capabilities expected of JMSDF are the amphibious combat capability and vertical lift capability possessed by some ships, which are mainly utilized in SAR missions. Also, compared to other countries, local governments have enough prepositioned supplies, and infrastructure is in place in each region, so it is extremely rare for JMSDF ships to utilize their landing and transportation capabilities.

Apart from these situations, Table 10 shows the evaluation of the capabilities of the ships (Janes, 2022). Huge ships such as the helicopter destroyer (DDH) and LST can be highly evaluated in many parameters such as transport capacity and can be effectively used in HADR operations. On the other hand, in HADR operations that do not require transport or landing capabilities, other ships also have high SAR capabilities and therefore can be utilized.

Table 10. JMSDF Ships to Capability Comparison. Adapted from Greenfield and Ingram (2011), Apte et al. (2013), Gastrock and Iturriaga (2013), Moffat (2014), and Gangcuangco et al. (2020).

HADR Capabilities	JMSDF Type Ship											
	DDH	DDG	DD	FFM	DE	MST	MSO	PG	LST	LCU	ATS	AMS
Aircraft support	3	2	2	2	1	2	1	1	3	1	2	1
Landing Craft support	1	1	1	1	1	1	1	1	3	3	1	1
Water Search and Rescue	3	3	3	3	3	2	2	1	3	1	2	2
Dry goods storage	3	2	2	2	2	3	1	1	3	3	2	2
Refrigerated goods storage	3	2	2	2	2	3	1	1	3	2	2	2
Fresh water storage/dispensation	3	2	2	2	2	3	1	1	3	1	2	2
Roll On Roll Off	3	1	1	1	1	1	1	1	3	3	1	1
Fuel storage/dispensation	3	1	1	1	1	1	1	1	1	1	1	1
Self Sufficient	3	3	3	3	3	3	1	1	3	3	3	3
Personnel transfer	3	3	3	3	3	3	3	3	3	1	3	3
Freshwater Production	3	1	1	1	1	3	1	1	3	1	1	1
Personnel support	3	3	3	2	2	3	1	1	3	1	2	2
Berthing capacity	3	3	2	2	2	3	1	1	3	1	2	2
Medical support	3	2	2	2	2	2	2	2	3	1	2	2
Transit speed	3	3	3	3	3	2	1	3	2	1	2	1
Hydrographic survey	1	1	1	1	1	1	1	1	1	1	1	1
Salvage Operations	1	1	1	1	1	1	1	1	1	1	1	1
Towing	2	2	2	2	2	2	1	1	2	1	2	2

HADR Capabilities	JMSDF Type Ship											
	AGS	AOS	AGB	ARC	ASR	ASE	AOE	ASY	TV	YT	YW	YO
Aircraft support	1	1	2	1	2	2	2	1	2	1	1	1
Landing Craft support	1	1	1	1	1	1	1	1	1	1	1	1
Water Search and Rescue	2	2	3	2	2	2	2	1	2	1	1	1
Dry goods storage	2	2	3	2	2	2	3	1	2	1	1	1
Refrigerated goods storage	2	2	3	2	2	2	3	1	2	1	1	1
Fresh water storage/dispensation	2	2	3	2	2	2	3	1	2	1	3	1
Roll On Roll Off	1	1	1	1	1	1	1	1	1	1	1	1
Fuel storage/dispensation	1	1	1	1	1	1	3	1	1	1	1	3
Self Sufficient	3	3	3	3	3	3	3	1	3	1	1	1
Personnel transfer	3	3	3	3	3	3	3	1	3	1	1	1
Freshwater Production	1	1	3	1	1	1	3	1	1	1	1	1
Personnel support	2	2	2	2	2	2	2	1	2	1	1	1
Berthing capacity	2	2	3	2	2	2	2	1	3	1	1	1
Medical support	2	2	3	2	3	2	2	1	3	1	1	1
Transit speed	1	1	2	1	1	1	2	2	3	1	1	1
Hydrographic survey	3	3	1	1	1	1	1	1	1	1	1	1
Salvage Operations	3	1	1	1	3	1	1	1	1	1	1	1
Towing	2	2	2	2	2	2	2	2	2	3	1	1

HADR Capabilities	JMSDF Type Ship						
	YG	YB	YL	YF	YOT	YDT	YTE
Aircraft support	1	1	1	1	1	1	1
Landing Craft support	1	1	3	1	1	1	1
Water Search and Rescue	1	1	1	1	1	1	1
Dry goods storage	1	1	2	1	1	1	1
Refrigerated goods storage	1	1	1	1	1	1	1
Fresh water storage/dispensation	1	1	1	1	1	1	1
Roll On Roll Off	1	1	3	1	1	1	1
Fuel storage/dispensation	1	1	1	1	3	1	1
Self Sufficient	1	1	1	1	1	1	1
Personnel transfer	1	1	1	1	1	1	1
Freshwater Production	1	1	1	1	1	1	1
Personnel support	1	1	1	1	1	1	1
Berthing capacity	1	1	1	1	1	1	1
Medical support	1	1	1	1	1	1	1
Transit speed	1	1	1	1	1	1	1
Hydrographic survey	1	1	1	1	1	1	1
Salvage Operations	1	1	1	1	1	1	1
Towing	1	1	1	1	1	1	1

The parameters set in Table 8, measured in the Likert Scale, were similarly applied to the ships owned by the JMSDF and evaluated to determine which ship is most capable of HADR operations.

D. FRAMEWORK OF ANALYSIS

We used a top-to-bottom approach, shown in Figure 6, in determining the appropriate naval asset or a mix of naval assets for HADR operations in coastal areas after a TY or STY strikes. The framework of analysis was conceptualized based on the previous research, particularly the platforms and their HADR capabilities (Greenfield & Ingram, 2011; Gastrock & Iturriaga, 2013; Gangcuangco et al., 2020), the numerical rating criteria for HADR capabilities (Moffat, 2014), the selection of naval assets commensurate to the different TC categories (Apte et al., 2013), and the national and local HADR policies of the Philippines and Japan. We ensure that the framework will fit the research question on what appropriate naval assets could be desirable for HADR operations in the coastal areas after the TC strikes. Factors of consideration include the current HADR capabilities of both navies of the Philippines and Japan, and the national HADR policies. These factors were discussed in the current chapter and the previous chapters and their relevance to this research was explained.

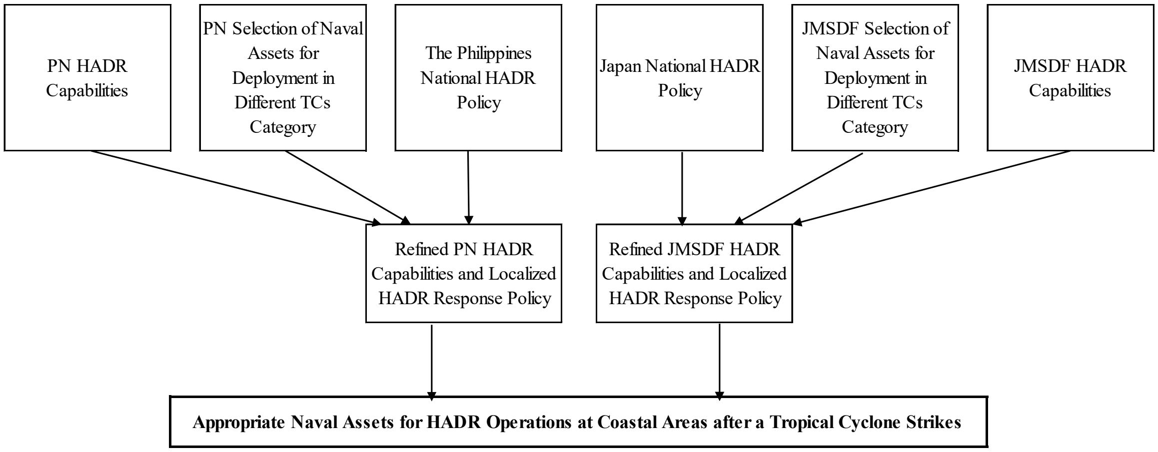

Figure 6. Framework for the Determination of Naval Assets for HADR Operations. Adapted from Greenfield and Ingram (2011), Apte et al. (2013), Gastrock and Iturriaga (2013), Moffat (2014), AND Gangcuangco et al. (2020). This figure shows the thinking process of decision-making in disaster relief and also shows the framework of analysis in this research.

In the next chapter, through this framework, we analyze the significant TYs and STYs that hit the Philippines and Japan and verify whether or not the parameters of HADR capabilities modified in this chapter were efficient and effective in HADR operations. Based on the results of the analyses, the appropriate types of navy ships were determined suitable to provide effective and efficient humanitarian logistics response to the affected areas after a TC strikes.

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V. ASSESSMENT

A. ANALYSIS OF SUPER TYPHOONS IN THE PHILIPPINES: HAIYAN (2013) AND GONI (2020)

STYs Haiyan (2013) and Goni (2020), two of the strongest TCs that hit the Philippines, recorded similar wind strengths but logged different results in damages to the population in terms of fatalities and number of people affected. Based on the situational reports of the NDRRMC, both STY Haiyan and STY Goni registered a maximum wind speed of 315 kph, equivalent to a category 5 TY under the SSHWS (NDRRMC, 2013; NDRRMC, 2020). Though both STYs have the same strength category and entered the PAR in the same quarter of the year, STY Haiyan on November 6, 2013, and STY Goni on October 29, 2020, STY Haiyan was deadlier than STY Goni. There were more than 6,000 deaths caused by STY Haiyan, while less than 30 were killed by STY Goni. Also, there were 28,688 injured and 1,062 missing individuals in STY Haiyan, compared to 399 injured and six missing persons in STY Goni.

Another significant finding is the comparison of the number of people affected by the two STYs in reference to the population densities of the locations traversed by both STYs. Based on the Philippine Statistics Authority (PSA) 2020 Population Index Report, the population density of the nine regions hit by STY Haiyan was only 411 people per square kilometer compared to 417 people per square kilometer in the eight regions traversed by STY Goni (Mapa, 2021). Though the population density in the areas devastated by STY Haiyan was smaller than the population density in the locations crossed by STY Goni, the number of the affected individuals was opposite in numbers. More than 16,000,000 people were affected by STY Haiyan, while more than 2,000,000 people were displaced by STY Goni (Jalad, 2013; Jalad, 2020).

The significant discrepancies shown in Table 11 must be attributed to the presence of the TY surge on STY Haiyan and the level of preparation and mitigation efforts on STY Goni (NDRRMC, 2014a, 2014b). Through lessons learned from STY Haiyan, several risk-reduction programs, preparedness, and mitigation efforts, like the institutionalization of the Incident Command System (ICS) and the revision of the NDRRM Plan to Version 2 were established and implemented (NDRRMC, 2014a, 2014b; NDRRMC, DSWD, OCD, 2016). After the onslaught of STY Haiyan, information sharing and data collection from the local level to the national level had become much easier when the ICS was fully implemented and when the NDRRM Plan Version 2 was used as a national disaster management plan.

Table 11. Comparison Overview of STYs Haiyan and Goni. Source: NDRRMC Situational Reports for STY Haiyan and STY Goni and PSA.

Comparison of STY Haiyan and STY Goni		
Details	**STY Haiyan (Yolanda)**	**STY Goni (Rolly)**
Duration	3 days	5 days
Entered PAR	Nov. 6, 2013	Oct. 29, 2020
First Landfall	Nov. 8, 2013	Nov.1, 2020
Leave PAR	Nov. 9, 2013	Nov. 3, 2020
Max Windspeed	315 kph	315 kph
TC Category (SSHS)	Category 5	Category 5
Affected Individuals	16,078,181	2,030,120
Affected Families	3,424,593	522,600
Deaths	6,300	25
Injured	28,688	399
Missing	1,062	6
Affected Regions	9	8
Population Density	411	417

Notice in the comparison of STY Haiyan (2013) and STY Goni (2020), both have similar maximum wind speed and category, but Haiyan is deadlier and has enormously affected more people than Goni even if the population density on the location traversed by the latter is higher than the former. TY surge to the populated coastal areas hit by Haiyan is one of the primary causes.

B. ASSESSMENT OF THE PHILIPPINE NAVY ROLES, MISSION, AND HADR CAPABILITIES

Guide by the conceptual framework of analysis discussed in the previous chapter, we assessed several reports and documents. These include NDRRMC's 94 situational reports (the last report number is 108, but only 94 are available on the NDRRMC's website https://ndrrmc.gov.ph/index.php/21-disaster-events/1329-situational-report-re-effects-of-typhoon-yolanda-haiyan.html), one update report, and one final report for STY Haiyan; 12

situational reports for STY Goni; the NDRRMC's STY Haiyan Documentary Report entitled: *Y It Happened*; and the NDRRMC Plan 2, which discloses the role of the PN in the national-level response, the specific tasks from the national government, and the critical navy ships' capabilities for DRRO.

In particular, the assessment reveals three lines of efforts the PN undertakes when the effect of a TC reaches the national level of response: (1) the main effort for SAR missions, especially in WASAR, (2) the supporting effort for the logistics cluster of NDRRMC, and (3) the supporting effort for other cluster members of NDRRMC. Aside from WASAR, all other tasks are related to logistics, as shown in Table 12. Frequently, navy ships were utilized as cargo ships and as transport platforms to deliver the relief supplies, equipment, and personnel from the point of embarkation to the point of debarkation, specifically unloading the cargoes on damaged ports and unfamiliar shores, not accessible to commercial ships.

The role of the PN ships and their missions in the national level of response reveals the essential capabilities of the ships' capabilities for effective and efficient HADR operations. These capabilities include WASAR, vertical lift support, medical support, berthing capacity, personnel and passenger support, dry and refrigerated goods storage, freshwater production, and support for vertical lifts and landing crafts for a ship-to-shore movement. Interestingly, the HADR operations in the coastal areas using these capabilities are similar to the amphibious operations of the Fleet-Marine Force and the at-sea-based logistics or sustainment of forces from the sea when a mother ship supports the surface assets within its proximity and the land forces for joint and prolonged operations. In amphibious operations, for example, the ship-to-shore movement of relief items and engineering equipment is comparable with the movement of troops and equipment of the landing force from the surface assets of the surface action group. Realizing the alignment and the similarities of the amphibious capability of the Fleet-Marine Force to the required capabilities of the navy for HADR operations has manifested that the doctrines, techniques, tactics, and procedures of the amphibious capability must be studied in the future.

Table 12. Assessment of the PN's Response during STY Haiyan and STY Goni

PN's Role in National-Level Response	PN's Role in Local-Level Response	Navy Ships' Mission	Ships' Capabilities Required
Main effort for Water Search and Rescue Cluster (WASAR)	Supporting effort for search and rescue (SAR)	WASAR/SAR	WASAR, Vertical lift support, Medical support
Supporting effort for Logistics Cluster	Supporting effort for relief operations and transport of supplies, equipment, and personnel	Transport of relief goods, engineering equipment, construction materials, and personnel	Berthing Capacity, Personnel and passenger support, Dry goods storage, Refrigerated goods storage, Freshwater production, Aircraft and Landing Craft support for the ship-to-shore movement, Roll-on roll-off
Supporting effort for other clusters on a need basis	Supporting effort as a logistics platform	Transport of relief goods, construction materials, medical supplies, and personnel	Berthing Capacity, Personnel Support, Dry goods storage, Refrigerated goods storage, FW Production, Aircraft and Landing Craft support for the ship-to-shore movement, Roll-on roll-off

The assessment of the situational reports of STYs Haiyan and Goni reveals the roles of the PN on HADR response, navy ship missions, and the required capabilities. The ships' mission depends on the role of response, while the needed capabilities of the ship coincide with the mission.

Another significant result of the assessment was the revelation of the critical and non-critical HADR capabilities necessary for PN ships to undertake the response and relief missions efficiently and effectively. In reference to the table of ships' HADR capabilities presented in Chapter IV, the capabilities were segregated into critical and non-critical based on the taskings from the Department of National Defense (DND) and other lead agencies of the different clusters of the national HADR organization during relief missions for STY

Haiyan and STY Goni. These taskings, captured on the published situational reports, disclosed 10 critical and five non-critical HADR capabilities as enumerated in Table 13 (Jalad, 2013; 2020; Apte & Yoho, 2014). Critical capabilities include WASAR, vertical lift support, medical support, personnel or passenger support, dry goods storage, refrigerated goods storage, freshwater storage and production, berthing capacity, landing craft support for the ship-to-shore movement, and roll-on roll-off capability. At the minimum, a ship or mix of ships to be deployed for HADR operations in the affected coastal areas should possess the critical capabilities to provide an effective and efficient HADR response in the coastal areas after the TY or STY strikes.

On the other hand, the non-critical capabilities comprise fuel storage and dispensation, transit speed, hydrographic survey, salvage operations capability, and towing capability. Aside from fuel storage and dispensation capability, which most navy ships are capable of, the listed non-critical capabilities are also special navy ships' capabilities that do not normally belong to the attributes of logistics ships or strategic sealift vessels but only for specific vessels. These special ships' capabilities are for special missions. For instance, transit speed is for fast boats, the hydrographic survey is for research vessels, and salvage and towing are for salvage vessels and tugboats. While some navy ships possess all of these capabilities, it is only in a limited capacity. Thus, no single ship shall be deployed for HADR operations, but a mix of ships or forces to complement all the needed capabilities for effective and efficient disaster response. The exception will be if a ship is designed for HADR operations and has all the required capabilities.

Table 13. Ships' Critical and Non-Critical HADR Capabilities. Adapted from Jalad (2013, 2020) and Apte and Yoho (2014).

Critical HADR Capabilities	Non-Critical HADR Capabilities
Water Search and Rescue (WASAR)	Fuel storage/dispensation
Vertical Lift Support	Transit speed
Medical Support	Hydrographic survey
Personnel and Passenger Support	Salvage operations
Dry goods storage	Towing
Refrigerated goods storage	
Freshwater storage/production/dispensation	
Berthing Capacity	
Landing craft support for the ship-to-shore movement	
Roll-on Roll-off	

The disclosure of the ships' required capabilities in Table 12 is instrumental in the identification of the PN ships' critical and non-critical HADR capabilities. Similarly, the JMSDF has the same set of critical and non-critical capabilities, but there are some differences in the U.S. Navy's mission-critical and non-critical capabilities (Apte & Yoho, 2014). In particular, the PN and the JMSDF use a more specific WASAR and vertical lift support than the SAR and air support used by the U.S. Navy. Also, due to the range and duration of the mission, fuel storage/dispensation is a non-critical capability for the PN and the JMSDF, while it is a critical capability for the U.S. Navy.

C. ANALYSIS OF TYPHOONS IN JAPAN: WIPHA (2013) AND HAGIBIS (2019)

As mentioned in the previous chapters, there are a few cases where the JMSDF ships respond to TYs. Considering the activities of the JMSDF over the last decade, the cases in which ships have been active are limited to TY Wipha (2013) and TY Hagibis (2019). Of course, non-ship vehicles are active against many TYs. In particular, aircraft are engaged in many SAR activities due to their high mobility, and many JMSDF members are involved in various activities along with the JGSDF (Ministry of Defense (MOD), n.d.), but because this study focuses on the activities of ships, we omit the discussion of these other activities.

1. Typhoon Wipha (2013)

TY Wipha was a TY that caused a lot of damage to Japan. In particular, it caused a great deal of rainfall on Oshima Island, an island near Tokyo, and caused enormous damage. A maximum of 122.5 mm of heavy rainfall was recorded per hour on Oshima

Island, and a debris flow struck the city area, causing 36 deaths in this debris flow alone (JMA, 2013). TY Wipha occurred near the Mariana Islands, moved north while strengthening its power, and proceeded from the Kanto region including Tokyo to the Tohoku region (Figure 7). Table 14 demonstrates that TY Wipha did not land in a densely populated area, so human damage was limited (Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications (FDMA), 2014).

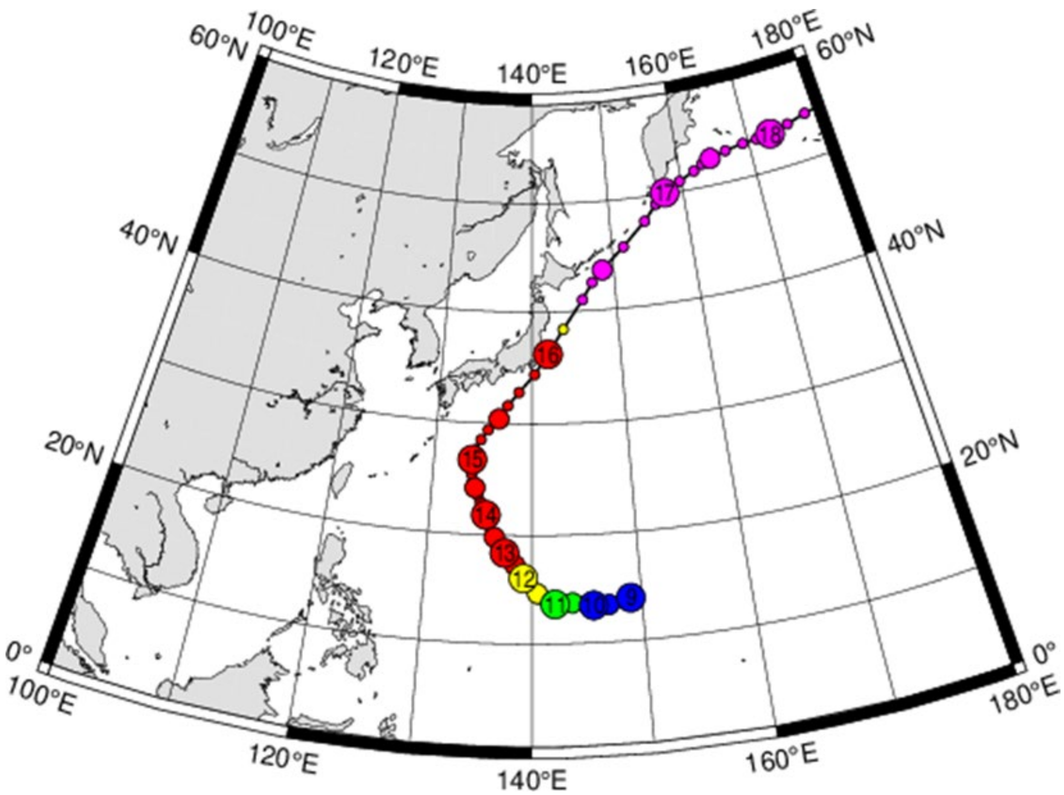

Figure 7. Route of TY Wipha (2013) through JAR. Source: Kitamoto (n.d.a). Shown is the course map of TY Wipha. It approached the Japanese archipelago while maintaining an extremely strong force and caused great damage to Oshima Island and other parts of Japan.

Table 14. Details of TY Wipha (2013). Source: EM-DAT, JMA, and FDMA

Duration	3 days
Entered JAR	Oct. 14, 2013
First Landfall	Oct. 16, 2013
Leave JAR	Oct. 16, 2013
Max Windspeed	167 kph
TC Category (SSHWS)	Category 2
Affected Individuals	19,289
Death	40
Injured	130
Missing	3
Population Density	337.93

The table shows the important details for TY Wipha. Notable is the number of affected individuals and death about the population density and maximum wind speed. In a developed country, like Japan, these numbers are already very high such that the government response must be aggressive enough to mitigate the suffering and save lives.

The JSDF formed JTF Tsubaki, under the command of the Commander of the Eastern Army, and the JMSDF organized a maritime disaster response unit with the Commandant of Yokosuka District as the commander. The JTF Tsubaki was active mainly in dispatching disaster responses to Oshima Island, and the JMSDF dispatched only two LSTs, Osumi and Kunisaki (MOD, 2013; Inoue, 2015).

These two LSTs were primarily engaged in transport missions. Since Oshima Island is a remote island away from the main island of Japan, it depends on shipping for many supplies. Air transport by JSDF units was carried out on a large scale, but it was not enough, so two LSTs were responsible for most of the transport. On the other hand, human damage was limited at sea, and SAR activities were mainly land-based (MOD, 2013).

2. Typhoon Hagibis (2019)

TY Hagibis was a large TY that caused great damage to various parts of Japan. The course of the TY was almost the same as TY Wipha, but it was slightly closer to the Japanese archipelago and caused serious damage (Figure 8). This TY flooded many rivers and more than 29,000 houses nationwide. It also paralyzed public transportation in the Kanto and Tohoku regions and destroyed a lot of infrastructures. As shown in Table 15, the direct hit to the Kanto region caused enormous human damage (JMA, 2019). In addition to a large number of deaths, the number of affected people was 390,470, a rare number in recent years (FDMA, 2020).

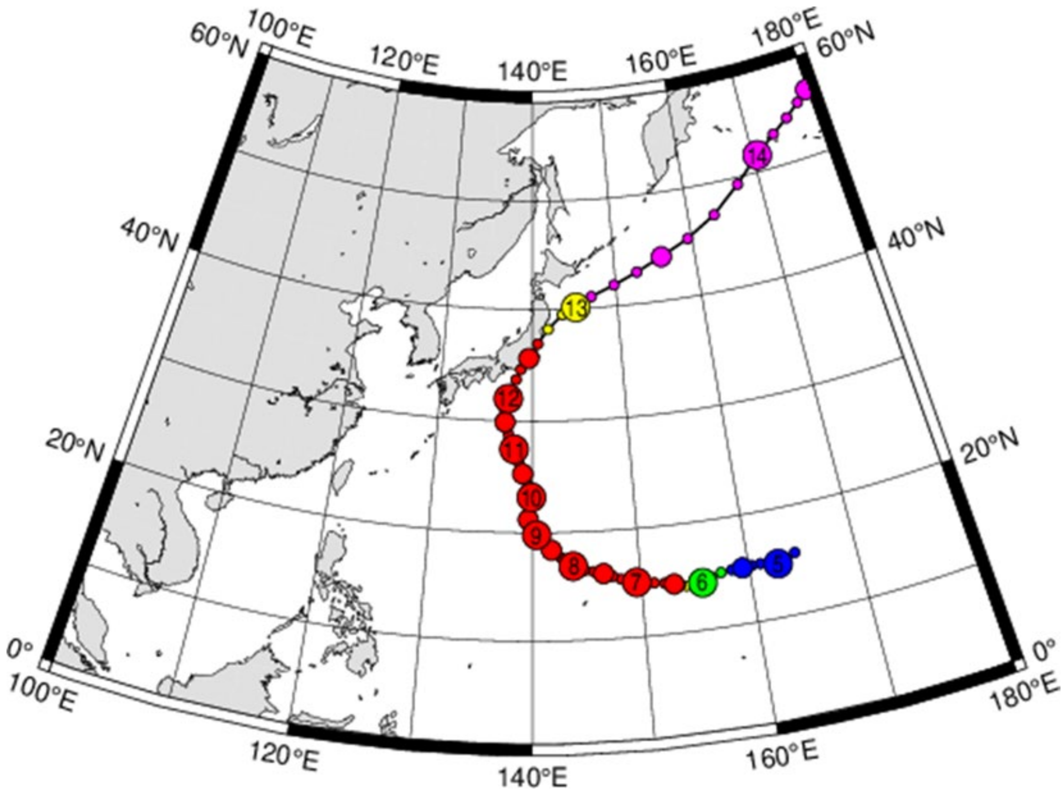

Figure 8. Route of TY Hagibis (2019) through JAR. Source: Kitamoto (n.d.b). Shown is the course map of TY Hagibis. The course is almost the same as TY Wipha, but a little westward, and landfall on the Japanese archipelago caused enormous damage to the Kanto and Tohoku regions.

Table 15. Details of TY Hagibis (2019). Source: EM-DAT, JMA, and FDMA

Duration	3 days
Entered JAR	Oct. 10, 2019
First Landfall	Oct. 12, 2019
Leave JAR	Oct. 13, 2019
Max Windspeed	160 kph
TC Category (SSHWS)	Category 2
Affected Individuals	390,470
Death	118
Injured	388
Missing	3
Population Density	677.16

The table shows the important details for TY Hagibis. The population density of the affected areas is much higher than the population density of the areas traversed by TY Wipha. As a result, the number of affected individuals and deaths is likewise higher.

Against TY Hagibis, the JSDF formed the JTF. Due to the great damage, the JGSDF in particular carried out large-scale activities. The Commander of the Ground Component Command took command of this JTF, and the maritime disaster response unit was commanded by the Commandant of the Yokosuka District. The JMSDF was planning to hold the observing ceremony on October 14, 2019, but canceled this ceremony due to this enormous disaster. The JMSDF incorporated a total of 12 ships that were scheduled to participate in this ceremony into this JTF and engaged in disaster response activities (MOD, 2019a; Operations Support Division of Operations and Plans Department, Maritime Staff Office, JMSDF, personal communication, March 17, 2022).

The JMSDF engaged in SAR activities in addition to transportation missions. The JMSDF dispatched two auxiliary multipurpose ships (AMSs) Suo and Ensyu, two DDHs Izumo and Kaga, LST Kunisaki, minesweeper tender (MST) Uraga, two ocean minesweepers (MSOs) Enoshima and Chichijima, service yacht (ASY) Hashidate, utility landing craft (LCU) No. 2, yard disposal tender (YDT), and yard water barge (MOD, 2019b; MOD, 2019c; MOD, 2019d; Ominato District, 2019; Operations Support Division of Operations and Plans Department, Maritime Staff Office, JMSDF, personal communication, March 17, 2022).

D. ASSESSMENT OF THE JAPAN MARITIME SELF-DEFENSE FORCE ROLES, MISSION, AND HADR CAPABILITIES

The JTF's missions for these two TYs are roughly divided into three: SAR operations, transportation of relief supplies to the affected, and direct support for the affected. The JMSDF does not carry out these three activities against all TYs. As mentioned in the previous chapter, many local governments are well prepared and can deal with relatively small damage caused by a TY. In addition, the community-based JGSDF is actively working against many TYs, and the room for the JMSDF to participate in these activities is extremely limited. In the event of enormous damage on a remote island such as during TY Wipha, however, or extremely widespread damage such as during TY Habigis, the JTF will be organized and the entire JSDF, including the JMSDF, will be engaged in HADR activities. At that time, as seen in these two TYs, the JMSDF ships provide many capabilities for these three main missions.

The first is SAR activities. These activities are performed through the use of other naval assets, including aircraft, but JMSDF ships can also provide significant WASAR capacity. Many JMSDF ships have RHIBs and other small boats and can engage in activities from a perspective closer to the surface of the water. In addition, the vertical lift is an essential ability for this WASAR operation, proven by the track record of ships with that capability who have been dispatched. On the other hand, although this SAR operation is the JSDF's main mission, this mission is mainly on land, and the mission at sea is relatively limited. It is extremely important to be able to provide sufficient capacity for this activity, however, because it is often the first requirement of the JSDF from the national and local governments.

The second is the transportation of relief supplies. If the road to the affected area is cut off or the affected area is a remote island, transportation by air is absolutely useful, but its loading capacity is highly limited. Many JMSDF ships can provide sufficient loading capacity, however, as evaluated in Chapter IV. LSTs and DDHs in particular can provide enormous transport capacity compared to other ships. As we saw in the previous section, these abilities were utilized in the two TYs that hit Japan. Especially in TY Wipha, the LST was equipped with air cushion landing crafts (LCACs) that could come ashore directly and thus were very useful even on remote islands that do not have large quays. In addition, LSTs and DDHs also have roll-on-roll-off capabilities, so they were able to call at various ports and provide a large number of relief supplies during the response to TY Hagibis.

The third is direct support for the affected people. This depends on the needs of the affected, so there are differences depending on the damage caused by the TY and the region. In these two TYs, however, freshwater supply support, food distribution, and medical support were provided. In addition, the ships' bathing facilities were opened, and simple bathing tents were installed to provide the affected people with an opportunity to refresh their minds and bodies. These activities can be provided sufficiently with the capabilities currently possessed by the JMSDF ships, but the medical support capability and freshwater capabilities of the LST and DDH are especially high.

A summary of the above discussions is shown in Table 16. Compared with PN, there are a lot of similarities. There is no big difference in the capabilities required of each ship, and various past examples prove it. In other words, at least in the Philippines and Japan, the capabilities required of ships to deal with TYs are very similar.

Table 16. Assessment of the JMSDF Response during TY Wipha (2013) and TY Hagibis (2019)

JMSDF's Role in Response	JMSDF Ships' Mission	Ships' Capabilities Required
Main effort for Water Search and Rescue Cluster (WASAR)	WASAR/SAR	WASAR, Vertical lift support, Medical support
Supporting effort for Logistics Cluster	Transport of relief goods, engineering equipment, construction materials, and personnel	Berthing Capacity, Personnel and passenger support, Dry goods storage, Refrigerated goods storage, Freshwater production, Aircraft and Landing Craft support for the ship-to-shore movement, Roll-on roll-off
Supporting effort for other clusters on a needed basis	Transport of relief goods, construction materials,	Berthing Capacity, Personnel Support, Dry goods storage, Refrigerated goods storage,

JMSDF's Role in Response	JMSDF Ships' Mission	Ships' Capabilities Required
	medical supplies, and personnel	Freshwater production, Aircraft and Landing Craft support for the ship-to-shore movement, Roll-on roll-off, Medical support

Based on the reports of STYs Wipha and Hagibis, the roles of the JMSDF on HADR response, navy ship missions, and required capabilities are similar to the assessment in the PN. The ships' mission depends on the role of response, while the required ships' capabilities coincide with the mission.

Taken altogether, some of the ships' capabilities set in Chapter IV are critical during TYs. Interestingly, the PN revealed that the classification of critical and non-critical ship capabilities needed for HADR operations, as tallied in Table 13, is the same as that for the JMSDF. In TY Wipha and TY Hagibis, the JMSDF provided 10 critical abilities, as many sources show (MOD, n.d.; MOD, 2013; MOD, 2019a; MOD, 2019b; MOD, 2019c; MOD, 2019d; Ominato District, 2019). On the other hand, few ships have these 10 critical abilities in a well-balanced manner, and LSTs and DDHs are typical examples. Therefore, these ships are dispatched not only for TYs but also for many other kinds of natural disasters in the past.

E. NAVAL CAPABILITIES NEEDED FOR HADR OPERATIONS IN THE COASTAL AREAS

Navy ships are often the first option to transport relief supplies to coastal areas immediately after a TY or a STY strikes because of their immediate availability and ship-to-shore movement capability. Numerous ships were engaged in the four TYs and STYs shown in the previous sections of this chapter. As the first course of action for DRRO, countries rely on whatever sea assets and equipment they have. For instance, the types of PN ships used in the STY Haiyan response were patrol vessels (PVs), LCUs, LSVs, patrol ships (PSs), and strategic sealift vessels (SSVs). PVs and other smaller vessels were used for short-distance transport missions but could only carry limited cargo, supplies, and personnel. For large volumes of supplies, heavy cargo, and big equipment, LSVs, SSVs, LSTs, and DDHs are the primary options because of their large cargo holding capacity.

In addition, HADR operations in the coastal areas require ships capable of ship-to-shore movement, either by vertical lift or by landing craft, to transport relief supplies, equipment, and personnel. Among the PN ships utilized in HADR operations for STY Haiyan and STY Goni, the SSV, or the LD type vessel, possesses all critical capabilities necessary to undertake the HADR missions in the Philippines efficiently and effectively, as tabulated in Table 9. It can accommodate two helicopters to provide limited vertical lift capability, has a RHIB, can support a Fleet-Marine Force amphibious capability with complementary landing craft capable of ship-to-shore movement, can billet hundreds of passengers close in numbers to a marine battalion, and can transport a large volume of cargo (Praveen, 2016). Other essential attributes of the LDs are their stability during inclement weather and their increased ability to navigate on rough seas compared to smaller vessels. Also, this ship has large fuel and fresh water tanks that enable it to stay longer at sea, which is essential for longer HADR missions. The LDs were not yet in service when STY Haiyan struck in 2013, however, and were only available in 2015. In the case of the JMSDF, multiple assets with vertical lift capability were used, such as LSTs and DDHs, for the ship-to-shore movement. As with the PN and the JMSDF, decision-makers are well aware of the usefulness of this critical capability, which is an essential aspect of each country's HADR response readiness. Aside from the capabilities previously cited, the LDs of the Philippines and the LSTs of Japan are also capable of supporting the transport and landings of battalion-size units and their equipment. Transporting relief supplies to remote areas where shore accessibility is limited only to ships with beach landing capabilities makes the mission less formidable through the use of the LCUs of LDs and LSTs.

Further, in the disaster life cycle, the PN and the JMSDF ships are only utilized in the response phase after the TC strikes and in the early phase of recovery. Generally, other government agencies are in charge during the preparedness phase and are using their available resources or commercial assets in the pre-positioning of relief supplies and full recovery operations. The capabilities of navy ships are best suited during the response phase wherein relief missions operate in full swing when commercial ships are not capable of transporting relief supplies and disaster response teams to the affected coastal areas.

Moreover, the naval capabilities needed for a national-level DR operation are comparable with the amphibious operations capability. A unique capability of naval ships to transport equipment and troops from the sea to the shorelines is not found in commercial ships. Complementary landing craft and vertical lift capabilities of the mother ship are the primary means for the ship-to-shore movement. With the ship-to-shore movement capabilities, the amphibious capability could be the most appropriate capability for HADR operations in coastal areas. The JMSDF has a wide array of surface assets, shown in Table 10 of Chapter IV, which could be used as mother ships for ship-to-shore movement. Their ships and other naval assets, like the LST and DDH, are capable of transporting the needed supplies and equipment to the areas that are badly hit and difficult to reach. Even though the Fleet-Marine Force has redundant capabilities, the PN ships do not need these capabilities to be effective. The important HADR capabilities of a ship are the things necessary to deliver supplies to the affected coastal areas after a STY or a TY strikes.

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VI. CONCLUSION

A. SUMMARY

Our research objective seeks to determine how the navies of the Philippines and Japan should select the appropriate naval capability or the mix of naval capabilities to efficiently and effectively respond to HADR operations. We also investigated the factors underlying the response of both navies in sending ships to the affected areas. In Chapter I, we defined the significance of our research, and this research presented our unique methodologies based on the data in the Philippines and Japan. In Chapter II, we gave an overview of the current state of disasters surrounding the Philippines and Japan and pointed out that TYs and STYs caused the greatest damage. In addition, we mentioned that the response of both governments was limited to a short-term response. In Chapter III, we conducted the literature review and looked at the classification of disasters and the disaster life cycle (Apte, 2009) that are the basis for understanding disasters. Furthermore, after reviewing the requirements for HADR operations pointed out by previous studies (Apte, 2009; Kovacs & Spens 2007), we developed the usefulness of the resource selection described by many researchers (Apte et al., 2013, 2020; Apte & Yoho, 2017, 2018). In Chapter IV, we examined the basic parameters and measurement scales of the TY data that are the subject of this study and defined the parameters that apply to the situation in the Philippines and Japan by applying from the previous studies. Then, based on these parameters, we defined the framework of analysis to be conducted in the following chapters after measuring the capabilities of the ships owned by the PN and the JMSDF. In the last chapter, we picked up four prominent STYs and TYs—STY Haiyan, STY Goni, TY Wipha, and TY Hagibis—and evaluated the roles, missions, and capabilities of PN and JMSDF ships based on actual data. We pointed out that there are three major efforts a navy is generally tasked with after a disaster strikes: (1) main effort for WASAR, (2) supporting effort for the logistics cluster, and (3) supporting effort for the other HADR clusters on a need basis. We also acknowledged the need for policymakers to make decisions by dividing the parameters defined in the previous chapter into those that are critical and non-critical.

Our research makes five contributions to those planning HADR operations in the PN and the JMSDF. First, we argue that the critical capabilities we identify should be the primary criteria when selecting ships. Second, we provide a table listing both critical and non-critical capabilities. Third, we argue that the role and mission of a navy in a particular disaster should be considered when deploying a mix of assets to respond to that disaster. Fourth, we argue that logistics and budgetary requirements should be forecasted in advance since TYs and STYs occur on a regular basis. Fifth, we provide information that can be useful to navies of other nations, particularly the U.S. Navy, responding to a request for support from the affected nation.

B. RECOMMENDATION

The disclosures of critical and non-critical capabilities provide excellent information on what type of ship and naval capabilities are the most appropriate for HADR operations in the coastal areas after a TY or STY strikes. All of the critical HADR capabilities can be found in the LD, the largest logistics ship in the inventory of the PN. While in the JMSDF, the most appropriate ship is the LST and the DDH.

Another notable finding is the application of the amphibious capability for HADR operations. With the experience and capability of the amphibious force in beach landings; ship-to-shore movement; and transport of goods, equipment, and personnel from the sea to the affected coastal areas, specifically if the areas are inaccessible to commercial ships, relief efforts can be both effective and efficient. This capability might constitute a whole HADR approach for the DR operations in the coastal areas.

Therefore, both governments in the Philippines and Japan can easily and effectively make future decisions based on our contributions. As mentioned in Chapter I and Chapter II, the two governments focused primarily on ad hoc disaster response, but it is appropriate based on the parameters in Table 8 and Table 13 that we derived. The proximity of ships to the affected areas is not always an advantage in the long run and hinders effective activities. Hence, the key here is to focus on the ships' critical capabilities and deploy ships that can provide the optimum service to the affected people.

C. THE WAY AHEAD

With little research on amphibious capability for HADR operations, this research might interest humanitarian logistics professionals in the military to examine its full future potential for relief and response missions in the coastal areas. It is also noteworthy to study further the sustainment of disaster response teams through sea-based logistics or the mother-ship concept. Sustainment could provide HADR responders with all the logistical requirements that they need from day one until the culmination of the mission.

Also, as demand in the affected areas is difficult to forecast, a mathematical model capable of determining the number of affected people could be a great leap for humanitarian logistics to minimize the inventory and gradually reduce the cost of operations. As appended to supplemental data, initial data could start on the wind speed, TY category, and population density of the TY path. Early forecasting of the affected individuals is not only useful during the response phase but in all phases of the disaster life cycle.

Finally, this study is limited to the Philippines and Japan. Although based on research in the U.S., further data verification and examination are required for application to other countries.

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APPENDIX: SUPPLEMENTAL DATA

Table 17. Philippines' Tropical Cyclones and Their Classifications (2000–2020). Source: PAGASA-DOST (2022).

Number	TC Name	Year	Wind Speed (kph)	TC Category/Classification		
				PAGASA-DOST (Philippines)	JMA (Japan)	SSHWS (U.S.)
1	Longwang (Biring)	2000	205	Typhoon	Typhoon	Category 3
2	Kirogi (Ditang)	2000	185	Typhoon	Typhoon	Category 3
3	Kai-Tak (Edeng)	2000	200	Typhoon	Typhoon	Category 3
4	Xangsane (Reming)	2000	140	Typhoon	Typhoon	Category 1
5	Bebinca (Seniang)	2000	120	Typhoon	Typhoon	Category 1
6	Rumbia (Toyang)	2000	135	Typhoon	Typhoon	Category 1
7	Lingling (Nanang)	2001	215	Super Typhoon	Typhoon	Category 4
8	Utor (Feria)	2001	140	Typhoon	Typhoon	Category 1
9	Conson (Jolina)	2001	100	Severe Tropical Storm	Severe Tropical Storm	No Category
10	Chataan (Gloria)	2002	170	Typhoon	Typhoon	Category 2
11	Soudelor (Egay)	2003	140	Typhoon	Typhoon	Category 1
12	Koni (Gilas)	2003	120	Typhoon	Typhoon	Category 1
13	Muifa (Unding)	2004	215	Super Typhoon	Typhoon	Category 1
14	Mindulle (Igme)	2004	230	Super Typhoon	Typhoon	Category 4
15	Xangsane (Milenyo)	2006	160	Typhoon	Typhoon	Category 2
16	Cimaron (Paeng)	2006	230	Super Typhoon	Typhoon	Category 4
17	Durian (Reming)	2006	195	Typhoon	Typhoon	Category 3
18	Prapiroon (Henry)	2006	120	Typhoon	Typhoon	Category 1
19	Utor (Seniang)	2006	150	Typhoon	Typhoon	Category 1
20	Mitag (Mina)	2007	170	Typhoon	Typhoon	Category 2
21	Fengshen (Franck)	2008	170	Typhoon	Typhoon	Category 2
22	Halong (Cosme)	2008	140	Typhoon	Typhoon	Category 1
23	Hagupit (Nina)	2008	165	Typhoon	Typhoon	Category 2
24	Neoguri (Ambo)	2008	175	Typhoon	Typhoon	Category 2
25	Nuri (Karen)	2008	150	Typhoon	Typhoon	Category 1
26	Dante (Kujira)	2009	148	Typhoon	Typhoon	Category 1
27	Chan-hom (Emong)	2009	140	Typhoon	Typhoon	Category 1
28	Parma (Pepeng)	2009	145	Typhoon	Typhoon	Category 1
29	Mirinae (Santi)	2009	140	Typhoon	Typhoon	Category 1
30	Ketsana (Ondoy)	2009	165	Typhoon	Typhoon	Category 2
31	Isang (Molave)	2009	120	Typhoon	Typhoon	Category 1
32	Conson (Basyang)	2010	120	Typhoon	Typhoon	Category 1
33	Megi (Juan)	2010	260	Super Typhoon	Typhoon	Category 5
34	Aere (Bebeng)	2011	95	Severe Tropical Storm	Severe Tropical Storm	No Category
35	Nock-ten (Juaning)	2011	120	Typhoon	Typhoon	Category 1
36	Nanmadol (Mina)	2011	195	Typhoon	Typhoon	Category 3
37	Nalgae (Quiel)	2011	240	Super Typhoon	Typhoon	Category 4
38	Nesat (Pedring)	2011	215	Super Typhoon	Typhoon	Category 4
39	Bopha (Pablo)	2012	260	Super Typhoon	Typhoon	Category 5
40	Nari (Santi)	2013	140	Typhoon	Typhoon	Category 1
41	Krosa (Vinta)	2013	140	Typhoon	Typhoon	Category 1
42	Haiyan (Yolanda)	2013	315	Super Typhoon	Typhoon	Category 5
43	Utor (Labuyo)	2013	195	Typhoon	Typhoon	Category 3

44	Rammasun (Glenda)	2014	165	Typhoon	Typhoon	Category 2
45	Hagupit (Ruby)	2014	215	Super Typhoon	Typhoon	Caegory 4
46	Kalmaegi (Luis)	2014	130	Typhoon	Typhoon	Category 1
47	Fung-Wong (Mario)	2014	85	Tropical Storm	Tropical Storm	No Category
48	Jangmi (Seniang)	2014	210	Typhoon	Typhoon	Category 4
49	Goni (Ineng)	2015	252	Super Typhoon	Typhoon	Category 5
50	Koppu (Lando)	2015	210	Typhoon	Typhoon	Category 4
51	Melor (Nona)	2015	185	Typhoon	Typhoon	Category 3
52	Lawin (Haima)	2016	215	Typhoon	Typhoon	Category 4
53	Nock-Ten (Nina)	2016	185	Typhoon	Typhoon	Category 3
54	Tembin (Vinta)	2017	125	Typhoon	Typhoon	Caegory 1
55	Mangkut (Ompong)	2018	240	Super Typhoon	Typhoon	Category 4
56	Yutu (Rosita)	2018	210	Typhoon	Typhoon	Category 4
57	Phanfone (Ursula)	2019	150	Typhoon	Typhoon	Category 1
58	Kammuri (Tisoy)	2019	210	Typhoon	Typhoon	Category 4
59	Goni (Rolly)	2020	315	Super Typhoon	Typhoon	Category 5
60	Vamco (Ulysses)	2020	155	Typhoon	Typhoon	Category 2
61	Vongfong (Ambo)	2020	185	Typhoon	Typhoon	Category 3
62	Molave (Quinta)	2020	155	Typhoon	Typhoon	Category 2

Table 18. Japan's Tropical Cyclones and Their Classifications (2000–2020). Source: JMA (2022).

Number	Name	Year	Wind Speed (kph)	TC Category/Classification		
				PAGASA-DOST (Philippines)	JMA (Japan)	SSHWS (U.S.)
1	Longwang	2000	84	Tropical Storm	Tropical Storm	No category
2	Kirogi	2000	126	Typhoon	Typhoon	Category 1
3	Saomai	2000	160	Typhoon	Typhoon	Category 2
4	Pabuk	2001	109	Severe Tropical Storm	Severe Tropical Storm	No category
5	Chebi	2001	126	Typhoon	Typhoon	Category 1
6	Danas	2001	126	Typhoon	Typhoon	Category 1
7	Halong	2002	108	Severe Tropical Storm	Severe Tropical Storm	No category
8	Sinlaku	2002	148	Typhoon	Typhoon	Category 1
9	Rammasun	2002	157	Typhoon	Typhoon	Category 2
10	Chata'an	2002	176	Typhoon	Typhoon	Category 2
11	Etau	2003	145	Typhoon	Typhoon	Category 1
12	Maemi	2003	200	Typhoon	Typhoon	Category 3
13	Megi	2004	126	Typhoon	Typhoon	Category 1
14	Chaba	2004	126	Typhoon	Typhoon	Category 1
15	Aere	2004	148	Typhoon	Typhoon	Category 1
16	Meari	2004	220	Typhoon	Typhoon	Category 4
17	Songda	2004	230	Super Typhoon	Typhoon	Category 4
18	Tokage	2004	230	Super Typhoon	Typhoon	Category 4
19	Ma-on	2004	260	Super Typhoon	Typhoon	Category 5
20	Dianmu	2004	285	Super Typhoon	Typhoon	Category 5
21	Mawar	2005	108	Severe Tropical Storm	Severe Tropical Storm	No category
22	Nabi	2005	144	Typhoon	Typhoon	Category 1
23	Shanshan	2006	222	Super Typhoon	Typhoon	Category 4

Number	Name	Year	Wind Speed (kph)	TC Category/Classification		
				PAGASA-DOST (Philippines)	JMA (Japan)	SSHWS (U.S.)
24	Fitow	2007	140	Typhoon	Typhoon	Category 1
25	Wipha/Goring	2007	185	Typhoon	Typhoon	Category 3
26	Man-Yi	2007	250	Super Typhoon	Typhoon	Category 4
27	Etau	2009	75	Tropical Storm	Tropical Storm	No category
28	Melor	2009	220	Typhoon	Typhoon	Category 4
29	Talas	2011	90	Severe Tropical Storm	Severe Tropical Storm	No category
30	Ma-on	2011	175	Typhoon	Typhoon	Category 2
31	Roke	2011	215	Typhoon	Typhoon	Category 4
32	Jelawat	2012	126	Typhoon	Typhoon	Category 1
33	Sanba	2012	204	Typhoon	Typhoon	Category 3
34	Bolaven	2012	240	Super Typhoon	Typhoon	Category 4
35	Toraji	2013	93	Severe Tropical Storm	Severe Tropical Storm	No category
36	Man-Yi	2013	121	Typhoon	Typhoon	Category 1
37	Fitow	2013	139	Typhoon	Typhoon	Category 1
38	Wipha	2013	167	Typhoon	Typhoon	Category 2
39	Nakri	2014	102	Severe Tropical Storm	Severe Tropical Storm	No category
40	Phanfone	2014	110	Severe Tropical Storm	Severe Tropical Storm	No category
41	Neoguri	2014	130	Typhoon	Typhoon	Category 1
42	Halong	2014	160	Typhoon	Typhoon	Category 2
43	Vongfong	2014	290	Super Typhoon	Typhoon	Category 5
44	Etau	2015	93	Severe Tropical Storm	Severe Tropical Storm	No category
45	Noul	2015	180	Typhoon	Typhoon	Category 3
46	Nangka	2015	185	Typhoon	Typhoon	Category 3
47	Goni	2015	198	Typhoon	Typhoon	Category 3
48	Chan-Home	2015	250	Super Typhoon	Typhoon	Category 4
49	Mindulle	2016	121	Typhoon	Typhoon	Category 1
50	Lionrock	2016	167	Typhoon	Typhoon	Category 2
51	Malakas	2016	185	Typhoon	Typhoon	Category 3
52	Chaba	2016	277	Super Typhoon	Typhoon	Category 5
53	Noru	2017	120	Typhoon	Typhoon	Category 1
54	Talim	2017	160	Typhoon	Typhoon	Category 2
55	Lan'/'Paolo	2017	216	Typhoon	Typhoon	Category 4
56	Trami	2018	216	Typhoon	Typhoon	Category 4
57	Jebi	2018	220	Typhoon	Typhoon	Category 4
58	Tapah	2019	121	Typhoon	Typhoon	Category 1
59	Hagibis	2019	160	Typhoon	Typhoon	Category 2
60	Faxai	2019	170	Typhoon	Typhoon	Category 2
61	Lingling	2019	176	Typhoon	Typhoon	Category 2
62	Julian	2020	175	Typhoon	Typhoon	Category 2
63	Haishen	2020	185	Typhoon	Typhoon	Category 3

PAGASA-DOST, JMA, and the U.S. National Hurricane Center have different classifications of TCs, as shown in the tables in Chapter IV. For instance, TSs and severe tropical storms with the wind speed range of up to 118.8 kph have no category on the SSHWS—its category 1 starts with 119 kph. Also, Japan only uses TYs as its highest classification even if the wind speed is more than 220 kph, the beginning windspeed of STY classification in the Philippines. Further, the highest storm category in the SSHWS is category 5 level with at least 252 kph wind speed, while Japan's highest classification of TC is TY with at least 118.9 kph, and the highest TC classification in the Philippines is STY registers of at least 221 kph.

Table 19. Philippines' Tropical Cyclones with the Number of Affected Individuals (2000–2020). Source: PAGASA-DOST (2022); PSA (2022).

Number	TC Name	Year	Wind Speed (kph)	SSHWS	Population Density of the Affected Locations	Number of Affected Individuals
1	Longwang (Biring)	2000	205	Category 3	1,150	235,889
2	Kirogi (Ditang)	2000	185	Category 3	21,765	120,000
3	Kai-Tak (Edeng)	2000	200	Category 3	572	1,483,321
4	Xangsane (Reming)	2000	140	Category 1	494	2,436,256
5	Bebinca (Seniang)	2000	120	Category 1	709	1,747,872
6	Rumbia (Toyang)	2000	135	Category 1	257	164,093
7	Lingling (Nanang)	2001	215	Category 4	246	1,060,147
8	Utor (Feria)	2001	140	Category 1	288	1,902,654
9	Conson (Jolina)	2001	100	No Category	567	295,355
10	Chataan (Gloria)	2002	170	Category 2	21,765	700,041
11	Soudelor (Egay)	2003	140	Category 1	257	127,130
12	Koni (Gilas)	2003	120	Category 1	147	116,602
13	Muifa (Unding)	2004	215	Category 1	642	838,674
14	Mindulle (Igme)	2004	230	Category 4	210	385,012
15	Xangsane (Milenyo)	2006	160	Category 2	412	3,842,406
16	Cimaron (Paeng)	2006	230	Category 4	275	283,021
17	Durian (Reming)	2006	195	Category 3	397	2,562,517
18	Prapiroon (Henry)	2006	120	Category 1	567	476,027
19	Utor (Seniang)	2006	150	Category 1	278	327,542
20	Mitag (Mina)	2007	170	Category 2	204	443,115
21	Fengshen (Franck)	2008	170	Category 2	347	4,785,460
22	Halong (Cosme)	2008	140	Category 1	348	1,496,668
23	Hagupit (Nina)	2008	165	Category 2	91	128,507
24	Neoguri (Ambo)	2008	175	Category 2	187	380,000
25	Nuri (Karen)	2008	150	Category 1	172	429,463
26	Dante (Kujira)	2009	148	Category 1	336	383,465
27	Chan-hom (Emong)	2009	140	Category 1	331	401,007
28	Parma (Pepeng)	2009	145	Category 1	476	4,478,491
29	Mirinae (Santi)	2009	140	Category 1	592	802,175
30	Ketsana (Ondoy)	2009	165	Category 2	375	4,901,763
31	Isang (Molave)	2009	120	Category 1	1,160	248,058
32	Conson (Basyang)	2010	120	Category 1	592	585,474
33	Megi (Juan)	2010	260	Category 5	275	2,009,026

Number	TC Name	Year	Wind Speed (kph)	SSHWS	Population Density of the Affected Locations	Number of Affected Individuals
34	Aere (Bebeng)	2011	95	No Category	559	430,092
35	Nock-ten (Juaning)	2011	120	Category 1	1,077	1,108,224
36	Nanmadol (Mina)	2011	195	Category 3	110	403,230
37	Nalgae (Quiel)	2011	240	Category 4	275	1,113,775
38	Nesat (Pedring)	2011	215	Category 4	459	3,030,846
39	Bopha (Pablo)	2012	260	Category 5	307	6,246,664
40	Nari (Santi)	2013	140	Category 1	331	871,755
41	Krosa (Vinta)	2013	140	Category 1	172	220,443
42	Haiyan (Yolanda)	2013	315	Category 5	411	16,106,870
43	Utor (Labuyo)	2013	195	Category 3	331	395,730
44	Rammasun (Glenda)	2014	165	Category 2	508	4,654,966
45	Hagupit (Ruby)	2014	215	Caegory 4	469	4,150,400
46	Kalmaegi (Luis)	2014	130	Category 1	172	431,086
47	Fung-Wong (Mario)	2014	85	No Category	879	840,360
48	Jangmi (Seniang)	2014	210	Category 4	346	578,549
49	Goni (Ineng)	2015	252	Category 5	172	318,383
50	Koppu (Lando)	2015	210	Category 4	416	2,898,590
51	Melor (Nona)	2015	185	Category 3	405	287,251
52	Lawin (Haima)	2016	215	Category 4	382	981,154
53	Nock-Ten (Nina)	2016	185	Category 3	343	1,893,404
54	Tembin (Vinta)	2017	125	Caegory 1	190	923,757
55	Mangkut (Ompong)	2018	240	Category 4	210	3,800,138
56	Yutu (Rosita)	2018	210	Category 4	371	544,568
57	Phanfone (Ursula)	2019	150	Category 1	395	3,297,246
58	Kammuri (Tisoy)	2019	210	Category 4	377	2,647,558
59	Goni (Rolly)	2020	315	Category 5	417	2,030,120
60	Vamco (Ulysses)	2020	155	Category 2	553	514,909
61	Vongfong (Ambo)	2020	185	Category 3	132	578,740
62	Molave (Quinta)	2020	155	Category 2	401	888,415

Table 20. Japan’s Tropical Cyclones with the Number of Affected Individuals (2000–2020). Source: JMA (2022); Statistics Bureau of Japan (2021).

Number	Name	Year	Wind Speed (kph)	SSHWS	Population Density of the Affected Location	Number of Affected Individuals
1	Longwang	2000	84	No category	813	12,100
2	Kirogi	2000	126	Category 1	6,403	900
3	Saomai	2000	160	Category 2	524	180,041
4	Pabuk	2001	109	No category	493	7,040
5	Chebi	2001	126	Category 1	117	1,333
6	Danas	2001	126	Category 1	6,403	1,215
7	Halong	2002	108	No category	268	579
8	Sinlaku	2002	148	Category 1	643	820
9	Rammasun	2002	157	Category 2	643	5
10	Chata’an	2002	176	Category 2	63	100,018

Number	Name	Year	Wind Speed (kph)	SSHWS	Population Density of the Affected Location	Number of Affected Individuals
11	Etau	2003	145	Category 1	74	2,180
12	Maemi	2003	200	Category 3	643	223
13	Megi	2004	126	Category 1	366	8,502
14	Chaba	2004	126	Category 1	504	180,050
15	Aere	2004	148	Category 1	492	2
16	Meari	2004	220	Category 4	207	10,089
17	Songda	2004	230	Category 4	107	40,900
18	Tokage	2004	230	Category 4	402	84,792
19	Ma-on	2004	260	Category 5	1,666	5,948
20	Dianmu	2004	285	Category 5	47	756
21	Mawar	2005	108	No category	266	94
22	Nabi	2005	144	Category 1	825	270,140
23	Shanshan	2006	222	Category 4	126	12,448
24	Fitow	2007	140	Category 1	215	982
25	Wipha/Goring	2007	185	Category 3	81	83
26	Man-Yi	2007	250	Category 4	174	40,012
27	Etau	2009	75	No category	474	2,000
28	Melor	2009	220	Category 4	562	5,119
29	Talas	2011	90	No category	202	1,300
30	Ma-on	2011	175	Category 2	350	55
31	Roke	2011	215	Category 4	505	308
32	Jelawat	2012	126	Category 1	280	18,225
33	Sanba	2012	204	Category 3	643	25,250
34	Bolaven	2012	240	Category 4	266	833
35	Toraji	2013	93	No category	173	4,336
36	Man-Yi	2013	121	Category 1	1,034	30,288
37	Fitow	2013	139	Category 1	643	4,392
38	Wipha	2013	167	Category 2	338	19,289
39	Nakri	2014	102	No category	97	4,401
40	Phanfone	2014	110	No category	1,240	8,766
41	Neoguri	2014	130	Category 1	149	666
42	Halong	2014	160	Category 2	197	21,750
43	Vongfong	2014	290	Category 5	535	1,198
44	Etau	2015	93	No category	359	60,046
45	Noul	2015	180	Category 3	484	45
46	Nangka	2015	185	Category 3	431	845
47	Goni	2015	198	Category 3	235	70
48	Chan-Home	2015	250	Category 4	643	27
49	Mindulle	2016	121	Category 1	348	3,703
50	Lionrock	2016	167	Category 2	79	6,004
51	Malakas	2016	185	Category 3	852	6,000
52	Chaba	2016	277	Category 5	63	137
53	Noru	2017	120	Category 1	403	1,389
54	Talim	2017	160	Category 2	316	21,656
55	Lan'/'Paolo	2017	216	Category 4	223	18,810
56	Trami	2018	216	Category 4	1,786	18,200
57	Jebi	2018	220	Category 4	1,013	3,900
58	Tapah	2019	121	Category 1	253	2,021
59	Hagibis	2019	160	Category 2	677	390,470
60	Faxai	2019	170	Category 2	2,766	120,150

Number	Name	Year	Wind Speed (kph)	SSHWS	Population Density of the Affected Location	Number of Affected Individuals
61	Lingling	2019	176	Category 2	228	9
62	Julian	2020	175	Category 2	643	8
63	Haishen	2020	185	Category 3	215	52

Listed in Table 19 are the TCs that made landfalls in the Philippines with at least 85 kph wind speed, their equivalent storm category in the SSHWS, the population density of the affected areas, and the number of affected people per TC occurrence. Recorded from 2000 to 2020, the list of TCs with international and local names and the number of affected individuals were gathered from PAGASA-DOST, while the population density was provided by the PSA. As discussed in Chapter IV, the SSHWS was used to categorize the TCs as the internationally accepted standard scale for storms, TC, and TY. As for Japan, Table 20 is constructed in the same way as the Philippines and its data from the Statistics Bureau of Japan and JMA.

This data from both countries were used when examining the correlation. We, however, could not find a good correlation between TC categories, population density, and the number of affected individuals.

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