THE ABILITY OF THE TRINIDAD AND TOBAGO DEFENCE FORCE (TTDF) LOGISTICS INFRASTRUCTURE TO SUPPORT REQUIREMENTS IN RESPONSE TO HUMANITARIAN AND DISASTER RELIEF (HADR)

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

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Civilian disaster response is quickly overwhelmed in large emergencies. Militaries fill this gap by providing unique capabilities to the disaster relief effort. Trinidad and Tobago's national disaster response involves the TTDF as a secondary responder. This thesis answered the question; what gaps exist in the ability of the TTDF to provide logistics support in response to Humanitarian Assistance and Disaster Relief operations.

This thesis examined Hurricane Ivan 2004, Hurricane Katrina 2005, Haiti earthquake 2010 and Hurricane Mathew 2016 against six criteria: the extent of damage and what was required; types of responses; who responded; elements of success; elements of failure; and the ability of the nation to respond.

This study suggested amendments to the National Response Framework, areas for TTDF improved capability, areas for study, and implementation.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

THE ABILITY OF THE TRINIDAD AND TOBAGO DEFENCE FORCE (TTDF) LOGISTICS INFRASTRUCTURE TO SUPPORT REQUIREMENTS IN RESPONSE TO HUMANITARIAN AND DISASTER RELIEF (HADR), by Major Jozette McLean, 123 pages.

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ACRONYMS

CARICOM	Caribbean Community
CDEMA	Caribbean Disaster and Emergency Management Agency
CDERA	Caribbean Disaster and Emergency Relief Agency
HA	Humanitarian Assistance
GORTT	Government of the Republic of Trinidad and Tobago
JTF-H	Joint Task Force-Haiti
JTF-M	Joint Task Force-Matthew
MINUSTAH	United Nations Stabilization Mission in Haiti
NGO	Non-Governmental Organization
NRF	National Response Framework
ODPM	Office of Disaster Preparedness and Management
SACSO	Security Assistance and Civil Support Operations
SAPSO	State and Public Security Operations
SCM	Supply Chain Management
SI	Supplier Involvement
SIDS	Small Island Developing States
SRFP	Sub-Regional Focal Point
T&T	Trinidad and Tobago
TTAG	Trinidad and Tobago Air Guard
TTCG	Trinidad and Tobago Coast Guard
TTDF	Trinidad and Tobago Defence Force
TTDFR	Trinidad and Tobago Defence Force Reserves
TTFS	Trinidad and Tobago Fire Service

TTPS	Trinidad and Tobago Police Service
TTR	Trinidad and Tobago Regiment
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNMIH	United Nations Mission in Haiti
US	United States
USAID	United States Agency for International Development
USCENTCOM	United States Central Command
USNORTHCOM	United Northern Command
USSOUTHCOM	United States Southern Command

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CHAPTER 1

INTRODUCTION

> Following the devastating impact of the Hurricane, the TTDF swung into action, arriving some 48 hours before any other Caribbean troops, and gradually building up into the largest contingent on the island. Deploying over 150 troops in a Joint Support Group (JSG), the TTDF transported some 1,276 tons of food and water along with 638 tons of construction material to Grenada. It played a pivotal role in restoring law and order in Grenada, provided relief and succor to the affected population, and helped to avert a health crisis by disposing of carcasses.
>
> — Badri-Maharaj, The Role of the Trinidad and Tobago Defence Force in Disaster Management

The Purpose of the Study

The purpose of this study was to investigate the Trinidad and Tobago Defence Force's (TTDF) role in and readiness for disaster response. This study identified the mandated roles of the TTDF in the National Response Framework (NRF), the role according to the Office of Disaster and Preparedness Management (ODPM) and the role according to the Caribbean Disaster and Emergency Management Agency (CDEMA 2010, 3). These roles, when compared to TTDF's current capacity, suggest the ability that the TTDF should have. The TTDF as a small military with limited resources, must, therefore, carefully select capability to develop that is the most cost effective, which enables national response and by extension regional response.

The study consists of five chapters laying out the research. Chapter 1 introduces the study and lays the foundation by discussing the purpose of the study, background, the issues, the problem, research questions, assumptions, definitions, limitations and delimitations, scope and significance of the study. Chapter 2 presents the literature review and is broken down into four major parts. Chapter 3 is the research methodology and

consists of two major parts. Chapter 4 is the presentation and analysis of the cases, broken down into two major parts. Chapter 5 is the final chapter containing the conclusion and recommendations for further study, implementation, and improvement.

The Problem

The Caribbean region is becoming more vulnerable to disasters as the frequency is increasing and the impacts are ever more devastating (Kirton 2013, 4). According to Cavallo, Powell, and Becerra (2010, 3), the Inter-American Development Bank estimated that the cost of the relief and response effort for the Haiti earthquake in 2010 was between US$7.2 and $13.9 billion. Haiti was, of course, unable to help herself and relied on international aid to support the population's needs. Haiti's case is extreme, but it lends significance to the question of whether Haiti should have been able to help her people by providing a necessary first response after the disaster. Jamaica responded with aid as the northern Sub-Regional Focal Point (SRFP). Jamaica's effort eventually became the Caribbean Disaster and Emergency Management Agency's (CDEMA) response to Haiti. The United States and the United Nation's troops together with Non-Governmental Organizations (NGOs) and Inter-Governmental Organizations had the greatest impact on Haiti's relief. Haiti was unable to help herself, and the Jamaican response provided the bulk of the regional aid efforts.

The problem is that the TTDF as one of the lead disaster response agencies for Trinidad and Tobago (T&T), has limited resources to perform its functions efficiently (Badri-Maharaj 2012, 10). T&T is designated as an SRFP for disaster relief and response locally and regionally and must be prepared to respond to save lives and restore property. However, TTDF's logistical and material limitations negatively influence the efficient

functioning of the system. Shortfalls persist such as transportation, storage facilities, the maintenance of individual power, fuel, and emergency supplies. These factors limit the ability to get resources to the required locations. Once deployed, there are also issues such as continuity of supply, feeding, sanitation spares, fuel, and other resources needed to support the troops that are engaged in the response effort.

Significance of Study

This study has the potential to increase the resources that are budgeted and subsequently made available to the TTDF for disaster response. Any improvements in TTDF doctrine, organization, training, material, and facilities will have a corresponding and significant effect on overall capability. This study has the potential to save lives since improved military disaster response mechanisms can enhance efficiency in disaster response. Finally, this work will also add to the body of knowledge for TTDF and Caribbean defense research.

Research Questions

Primary Question

After consideration of the problems listed above, this thesis seeks to answer this research question: “What gaps exist in the ability of the TTDF to provide logistics support in response to Humanitarian Assistance and Disaster Relief Operations?”

Secondary Questions

1. What is the role of the TTDF in disaster relief and humanitarian assistance?
2. What constitutes sufficient preparedness for a potential disaster?
3. How well can TTDF respond to disaster relief requirements?

4. How well does TTDF integrate with the Office of Disaster Preparedness and Management (ODPM) and Caribbean Disaster and Emergency Management Agency (CDEMA)?

Tertiary Questions

1. What lessons learned emerge from case studies?
2. What do recent case studies reveal about TTDF's ability to respond to disaster relief requirements?
3. How much capability is enough and is an increase required?
4. How could improved integration increase capability?
5. Does improved HADR capability improve overall TTDF capabilities?

Background

Several factors predispose the Caribbean region for disasters with devastating impacts: poor urban planning, deforestation and other damaging farming practices, poor and unplanned drainage, geology, location, topology and limited response capabilities, to name a few. The United Nations Economic Commission for Latin America and the Caribbean (UNECLAC) conducted research which concluded that hurricanes in the region had caused approximately US$5.7 billion in damage; the estimate for 2004 alone was US$2 Billion (UNDP 2011, 11). Geological hazards in 2010 resulted in the loss of 230,000 lives, with more than two million persons left homeless.

Small Island Developing States (SIDS) of the Caribbean are particularly vulnerable to a range of disasters, both natural and man-made (UNDP 2011, 23). There is, therefore, an increased realization of the need to develop capabilities to prevent,

mitigate and respond to disasters. T&T, as one of the largest islands in the Caribbean and the most economically developed among English-speaking islands, has a mandated responsibility through the Caribbean Community (CARICOM) Caribbean Disaster Emergency Management Agency (CDEMA 2013, 10) to respond with aid if requested.

Trinidad and Tobago and a few other islands founded CARICOM in 1973. Today it consists of 15 full members, five associate members, and eight observers (see figure 1).

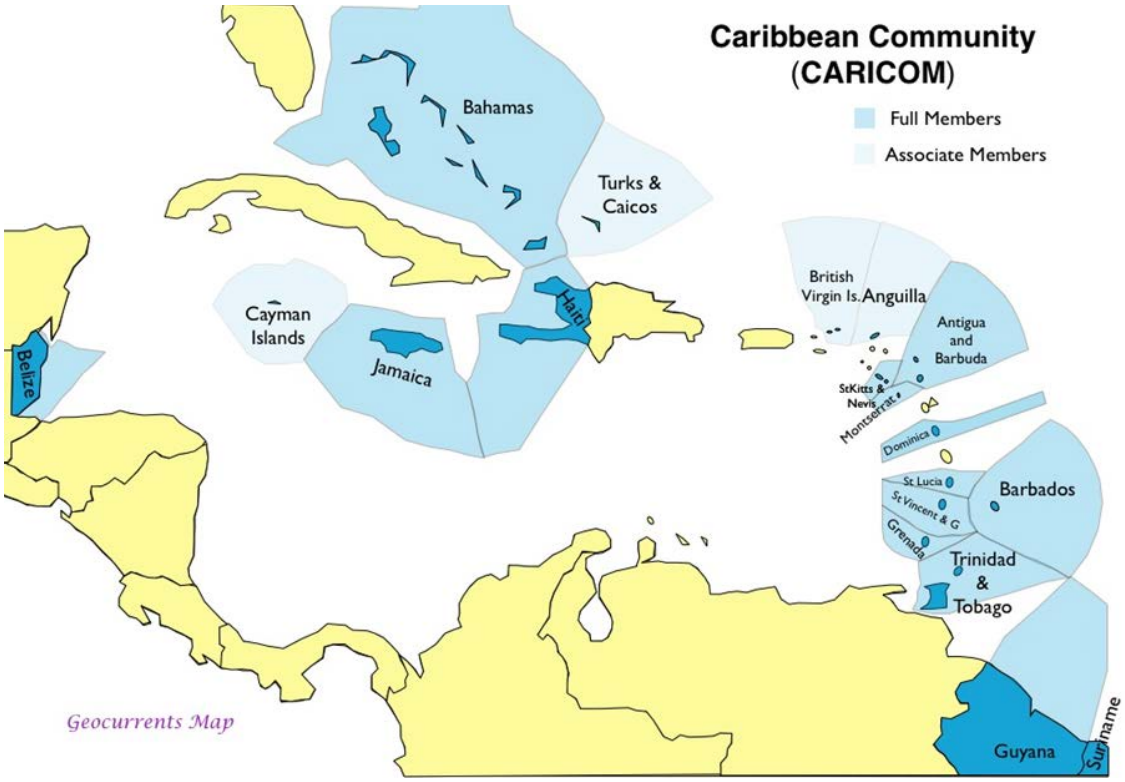


Figure 1. Map Showing Caribbean Region and Members of CARICOM

Source: Jamaica Coalition of Service Industries, "Trained Household Helpers Can Now move Freely Across the Region," *Jamaica Observer*, 14 February 2014, accessed 17 April 2017, http://jamaicacsi.org/trained-household-helpers-can-now-move-freely-across-the-region/.

The CARICOM's main purposes are to promote regional economic integration and cooperation among member states, to ensure that there is equity in benefits of integration, and to coordinate foreign policy. All of the associate members are British Overseas Territories. However, there is no permanent role for the associate members. The observer states are members of CARICOM's technical committees. These committees help coordinate economic policy amplification and development planning. They devise and implement special projects for the lesser developed islands and operate as a single market (Treaty establishing the Caribbean Community 1973).

Participating CARICOM states comprise four sub-groups headed by a Sub-Regional Focal Point (SRFP) to manage the sub-regional response (CDEMA 2010, 7). Trinidad and Tobago, as an SRFP, has responsibility for the southern nations of the Caribbean. However, Kirton (2013, 7) indicated that while SRFPs (Jamaica, Antigua, Barbados and Trinidad and Tobago) have consistently focused on performing roles assigned by CDEMA, logistics capability is a constraint. Logistical and material limitations negatively influence the efficient functioning of the sub-regional response system. For example, sub-regional focal points noted that they could not maintain individual power, fuel, and emergency supplies. Kirton (2013, 7) also said that further restrictions arise when SRFPs need to transfer supplies and personnel to those countries for which they are responsible. There are no dedicated storage facilities, and transport is inadequate. There are also issues regarding the support of the relief personnel. There are issues for their continuity of supply, feeding, sanitation, spares, fuel, and other resources needed to support the troops that are engaged in the response effort. Robinson (2004, 53) spoke about assistance being provided by some Island States, but due to inherent

shortfalls, the responders could not sustain themselves and had to rely on local support and or international support.

At the national level, the Trinidad and Tobago NRF lays down a tiered response to disasters regarding both escalations in time and severity (Appendix C). Tiers 1 through 3 stipulate the triggers for escalation of response and the entities that are required to respond at each level. This model has some overlap since the tiered response does not synchronize with the phases of a disaster and the actions at each stage.

The tiered NRF is designed to escalate in congruence with the acceleration of the disaster. The first level is at the individual level. If the individual can cope deal with the incident, then the response effort does not go beyond Level 1. Beyond personal response is the community response or the local response. The Municipal or Regional Cooperation responds at this level. Even at this level, soon after the event, elements of the TTDF are required to assist with an assessment to determine damage and requirements. The TTDF prepares to deploy at a very early stage of the disaster despite the municipal efforts. The local response seems to work, but the TTDF is always expected to turn up where communities are affected. At the third and highest level of the NRF, upon the declaration of a national disaster, the Ministry of Foreign Affairs, ODPM, and the TTDF coordinate assistance. The TTDF, as one of the major players in disaster relief and response, must be prepared to respond to save lives and restore property.

Trinidad and Tobago NRF states the following humanitarian and disaster relief roles for TTDF: “The four formations of the Trinidad and Tobago Defence Force– Regiment, Coast Guard, Air Guard, and Reserves–together contribute land, sea and air capabilities to the Force’s response efforts. Some roles include damage assessment,

search, and rescue, security/crowd control, relief supply distribution, hazardous material handling, and collapsed structure search and rescue" (Office of Disaster Preparedness and Management 2010).

Among these, the Government of the Republic of Trinidad and Tobago (GORTT) mandates the First Engineer Battalion of the TTR to work directly with the ODPM in times of emergency. The most probable national emergencies include floods, landslides, fires, mud volcanoes, biological emergencies and industrial accidents. T&T has never had a large biological incident or an industrial accident (Badri-Maharaj 2012, 7).

According to the NRF, the Engineer Battalion's functions include:

> 1. "Assisting the Trinidad and Tobago Fire Service (TTFS) and Trinidad and Tobago Police Service (TTPS) with search and rescue operations, and TTPS with law enforcement, during an emergency above Level 1.
>
> 2. Assisting the Ministry of the People and Social Development (MOPSD) to provide mass care services such as shelter, food and first aid.
>
> 3. Assisting the Ministry of Local Government (MOLG) Disaster Management Unit (DMU) and the ODPM with damage and needs assessments after an incident.
>
> 4. Assisting the MOPSD with the collection, analysis, and dissemination of information in order to facilitate the overall provision of services and resources during an emergency or disaster." (Office of Disaster Preparedness and Management 2010, 9)

The TTDF comprises the Trinidad and Tobago Regiment (TTR), the Trinidad and Tobago Air Guard (TTAG) and the Trinidad and Tobago Defence Force Reserves (TTDFR). The Regiment was established in 1962 when the two Battalions of the Federation of the West Indies were divided into its parts. The 1st Battalion became the 1st Battalion of the Jamaica Regiment, and the 2nd Battalion became the 1st Battalion of the Trinidad and Tobago Regiment. At that time, the role of TTR as stated in Chapter

14:01 of the Defence Act, Section 5 (2), was “to provide for the defense of Trinidad and Tobago and any other duties which may from time to time be defined by the Defence Council.” Arguably, that role has changed to include security, but the Defence Act does not reflect this change. The enhanced military roles are reflected in the TTR operations framework as follows:

1. Security Assistance and Civil Support Operations (SACSO);
2. State and Public Security Operations (SAPSO);
3. Civic Assistance and Military Sustainment Operations;
4. Development Assistance and Civil Defence Operations.

Over the years, the TTR has participated in only a few conflicts. These conflicts are categorized under SACSO and include the quelling of the mutiny of members of the TTR in 1970, and the suppression of the Jamaat al Muslimeen attempted coup in 1990. DACDO integrates the strategic priority of humanitarian and disaster relief support to the national efforts of the Office of Disaster Preparedness and Management (ODPM) and regional efforts of the Caribbean Disaster and Emergency Relief Agency (CDERA, now called CDEMA).

During the months of the hurricane season, the Engineer Battalion activates its disaster response element which is on alert for emergency response should the need arise locally or regionally. The Engineer Battalion is equipped to provide humanitarian and disaster relief assistance in the aftermath of a natural disaster. They can produce limited vertical and horizontal construction as well as flood and other damage assessment and limited relief. The forecast of heavy rain or flooding immediately places the TTDF on standby to support the national response framework.

The TTDF possesses the capability for collapsed structure, sea, and aerial search and rescue, rapid response, and some limited logistical response. The TTDF has contributed troops to regional efforts for humanitarian and disaster relief missions. Since its formation, TTR provided troops to the peacekeeping mission in 1983 to 1984 after the United States mission in Grenada, Operation Urgent Fury. GORTT contributed troops in the aftermath to ensure the maintenance of law and order. From 1993 to 1996, TTDF contributed to the United Nations Peacekeeping Mission in Haiti (UNMIH) as a major part of the CARICOM contingent. Subsequently, from 2004 to 2005, TTDF deployed troops to Grenada to provide relief in the aftermath of Hurricane Ivan. Following the Haiti earthquake in 2010, TTDF did not contribute any troops to the humanitarian effort.

Assumptions

The author assumes that CARICOM will not change its model within the foreseeable future. This consistency means that T&T will remain as the southern SRFP with responsibility for the southern Caribbean islands. Also, there is an assumption that the military will always have a role in disaster response, whether big or small. The military is not the first responder and will not become the first responder, but must be prepared to respond when the disaster is of such an enormous magnitude that local civilian response yields limited benefits. The Office of Disaster Preparedness and Management (ODPM) National Response Framework indicates that TTDF will be called on to collaborate with other national first responders to assist impacted citizens. The author assumes that this framework for disaster response will not change for Trinidad and Tobago.

Definition of Terms

Caribbean Community (CARICOM): "The Caribbean Community (CARICOM) is a grouping of twenty countries: fifteen Member States and five Associate Members. It came into being on 4 July 1973 with the signing of the Treaty of Chaguaramas by Prime Ministers Errol Barrow for Barbados, Forbes Burnham for Guyana, Michael Manley for Jamaica and Eric Williams for Trinidad and Tobago. CARICOM rests on four main pillars: economic integration; foreign policy coordination; human and social development; and security market" (Treaty establishing the Caribbean Community 1973).

Caribbean Disaster and Emergency Management Agency (CDEMA): "The Caribbean Disaster Emergency Management Agency (CDEMA) is a regional inter-governmental agency for disaster management in the Caribbean Community (CARICOM). It is presently comprised of eighteen (18) Participating States (PS): Anguilla, Antigua and Barbuda, Commonwealth of the Bahamas, Barbados, Belize, Commonwealth of Dominica, Grenada, Republic of Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, Suriname, Republic of Trinidad & Tobago, Turks & Caicos Islands and the Virgin Islands. The Agency was established in 1991 as CDERA (Caribbean Disaster Emergency Response Agency) with primary responsibility for the coordination of emergency response and relief efforts to PS that require such assistance" (CDEMA).

Disaster: "Uncontrollable events that are coordinated in time or space, in which a society undergoes severe danger and incurs such losses that the social structure is disrupted and the fulfilment of all of the essential functions is prevented" (Fritz 1961 cited in Ramsden 2014, 18).

"Events that produce death and destruction and cause considerable social, political and economic disruption" (Smith cited by Rodriguez et al, 2006 cited in Ramsden 2013, 19).

Fuerzas Aliadas Humanitarias (FAHUM): "a disaster response planning and coordination exercise which includes civilian officials, military forces and police officers from Central American and Caribbean Nations and the United States, as well as representatives of regional and international organizations" (U.S. Army South Public Affairs 2010).

Humanitarian Assistance (HA): "Humanitarian assistance is aid to an affected population that seeks, as its primary purpose, to save lives and alleviate suffering of a crisis-affected population. Humanitarian assistance must be provided in accordance with the basic humanitarian principles of humanity, impartiality and neutrality" (UNOCHA 2007, 7).

Humanitarian Supply Chain: "encompasses the planning and management of all activities related to material, information and financial flows in disaster relief. Importantly, it also includes coordination and collaboration with supply chain members, third party service providers and among humanitarian organizations . . . it can be argued that humanitarian supply chains need a combination of military and commercial application" (Abidi Leeuw, and Klumpp 2013, 32).

International Disaster Relief Assistance (IDRA): "comprises material, personnel and services provided by the international community to an affected state at its request, to meet the needs of the people affected by a disaster. The primary purposes of IDRA are to save lives and alleviate suffering" (Wiharta et al. 2008, 2).

Military and Civil Defense Assets (MCDA): "MCDA comprise relief personnel, equipment, supplies and services provided by foreign military and civil defense organizations for IDRA. Further, for the purpose of this project, civil defense organization means any organization that, under the control of a Government, performs the functions enumerated in paragraph 61 of Additional Protocol I to the Geneva Conventions of 1949. When these forces are under UN control they are referred to as UN MCDA" (UNOCHA 2007, 7).

Office of Disaster Preparedness and Management (ODPM): "The ODPM is the country's strategic disaster management agency which mobilizes and coordinates the country's key agencies and resources to improve national disaster risk reduction and emergency management. In so doing, the ODPM integrates the competencies and capabilities of the Defence Force and Protective Services, Ministries and Agencies, the Private Sector, Non-Governmental Organizations, Community and Faith Based Organizations, and other key stakeholders to prepare for, mitigate, respond to and recover from disasters" (Office of Disaster Preparedness and Management 2010, 11).

Supply Chain: "a network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products or services in the hands of the ultimate consumer" (Abidi, Leeuw, and Klumpp 2013, 32).

The author noted that in several pieces of work, the term logistics is used interchangeably with supply chain management, so the scope broadened to include literature on supply chain management. Most definitions of supply chain management explicitly recognize the existence of two flows through the chain; there is a flow of goods

and an equally important flow of information (Fisher 1997, Pagell 2004 as quoted in Prajogo and Olhager 2009, 2).

Limitations

Although there is significant data available on military responses to disasters; there is limited research on responses by developing nations and their militaries. Therefore, this limits the cases available that apply to this study. This research included an assessment of the ability of TTDF to integrate its resources for a regional disaster relief response in an attempt to assess overall capability gaps for disaster response. The TTDF has an increasing role in disaster response on paper, but the importance placed on the development of capability does not reflect this growing role. TTDF has a limited capacity to respond to disasters since TTDF uses the same equipment for disaster response and self-sustainment in conventional and other operations. Also, there has been no allocation of resources dedicated to research and development of policies, procedures, and study of lessons learned. Robinson (2004, 56) spoke about limited study and expenditure devoted to TTDF disaster relief capability development. Therefore alternative sources had to be used to obtain research material on TTDF operations and capacity. There may also be author biases due to the fact the researcher is studying her own organization and its capabilities.

Scope and Delimitations

This study was delimited to focus on the TTDF capability to perform national roles for disaster relief and its capacity to fulfill this mandate. Early in the research process, the author reduced the scope from investigating both regional and national

requirements to a focus on the requirements for national disaster response. There is, however, understanding that TTDF capability once developed can be employed either nationally or regionally.

Summary and Conclusions

Published research exists on the effectiveness of international militaries, and their response to disasters. Additionally, research exists on the question of whether the military should play a more important role or if they should they be injected for disaster response much earlier than they are now. This paper explores research thus far, and lessons learned from the case studies to identify gaps which exist in the ability of the TTDF to provide logistics support in response to humanitarian assistance and disaster relief operations and recommended solutions.

Trinidad and Tobago's location within the Caribbean basin just south of the hurricane belt means that it is well poised to play a significant role in regional disaster response. The military, due to its inherent capacity for self-sustainment and crisis response, is a vital entity in national response efforts. Civilian capacity is often quickly overwhelmed, so military efforts are frequently required. Countries affected by disasters frequently turn to their neighbors for assistance due to the proximity of assets and reduced time to respond. Additionally, there is usually a better political and cultural understanding of neighboring countries. Therefore, it is understandable, expected and mandated by CARICOM that Trinidad and Tobago, and by extension TTDF, is capable of providing assistance to neighboring islands.

Overall, there is the potential to reduce the loss of lives due to inefficiencies in the current response mechanism to national disasters. The increasing frequency and impact of

disasters, together with the vulnerability and devastating effects in the Caribbean, requires that urgency and importance be attached to improve response efforts through resourcing. It is important to understand the current methodologies used by TTDF for disaster response and identify where there may be shortfalls. It is also prudent to investigate the relationship for disaster response between TTDF and ODPM and their coordination of the national response. The review of case studies where TTDF and other militaries responded to disasters showed areas for lessons to be learned.

The remainder of this study is organized into four chapters. Chapter 2 discussed the literature relevant to the importance of logistics in disaster response, the use of militaries in disaster response, and the four cases studied. It answered five questions. Chapter 3 described the research methodology. Chapter 4 laid out the data from the case studies using the methodology described in Chapter 3 and answered the secondary and tertiary questions. Chapter 5, the final chapter of the study, presented the conclusions garnered from the analysis, as well as recommendations for further study, research, and implementation.

CHAPTER 2

LITERATURE REVIEW

Introduction

The purpose of this study is to investigate the TTDF's role and readiness in disaster response. This study sought to answer the primary research question: "What gaps exist in the ability of the TTDF to provide logistics support in response to Humanitarian Assistance and Disaster Relief operations?"

The secondary questions are:

1. What is the role of the TTDF in disaster relief and humanitarian assistance?
2. What constitutes sufficient preparedness for a potential disaster?
3. How well can TTDF respond to disaster relief requirements?
4. How well does TTDF integrate with the Office of Disaster Preparedness and Management (ODPM) and Caribbean Disaster and Emergency Management Agency (CDEMA)?

The tertiary questions are:

1. What lessons learned emerge from case studies?
2. What do recent case studies say about TTDF's ability to respond to disaster relief requirements?
3. How much capability is enough and is an increase required?
4. How could improved integration increase capability?
5. Does improved HADR capability improve overall TTDF capabilities?

This chapter was organized in five parts and seeks to answer five broad questions:

1. Firstly, what are the organizational performance management and logistics models that are relevant to disaster response? Why are they relevant?
2. Secondly, what is military effectiveness and how is it measured?
3. Thirdly, what does literature say about the roles of the military for disaster relief operations?
4. Fourthly, what role does TTDF play in disaster relief? These paragraphs discuss the perceived and mandated roles of TTDF in humanitarian assistance.
5. Lastly, what do the case studies tell us?

What are the Organizational Performance Management and Logistics Models that are Relevant to Disaster Response? Why are they Relevant?

Organizational Performance Measurement

Logistics is one, if not the most important elements in any disaster relief effort. It can make the difference between a successful and a failed operation. However, Van Wassenhove (2006) (quoted in Cozzolino 2012, 5) said that it is also usually the most expensive part of any disaster relief effort: estimates show that logistics account for about 80 percent of the total costs in disaster relief. What are the criteria used to measure an organization's logistics performance? There must be at least two key performance criteria to assess the performance of an organization. As mentioned by Beamon (1999) (in Deshpande 2012, 3), some supply chain models use one performance measurement tool and exhibit flaws. As such some researchers identified that supply chain performance measurement includes cost, time and flexibility (Neely, Gregory, and Platts 1995 in Deshpande 2012, 3).

Oloruntoba and Gray (2002) (in Lu et al. 2006, 178) found that there is more research on business logistics in developed than developing countries. Even less research exists on HA logistics in either emergency or development situations in developing countries. The existing models are not easily transferable to HA situations due to factors that exist in developing countries and many affected regions. This work was subsequently extended by Choi et al (2010, 25) to develop a model which broadly reflects the flow of goods within the HA system.

However, optimizing the logistic performance requires that all the relationships among the actors involved be "managed through an integrated approach to efficiently and effectively coordinate inter-organizational performance, eliminate redundancy, and maximize efficiency along the entire emergency supply chain, the supply chain management point of view," (Cozzolino 2012, 6). According to Beamon and Balcik (2008), "the increased frequency and scale of disasters, scarce resources, funding competition, and the need for accountability require more efficient, effective and transparent relief operations that must be effectively measured."

To assess the effectiveness of the humanitarian response, Apte et al. (2013, 46) in figure 2, identified six basic traits associated with the results of disasters and the corresponding relief requirements based on the presence of the trait. This framework provides a basis for the formulation of disaster requirements and therefore initial capabilities that may be required based on these generic traits. It forms a basis for self-evaluation by relief agencies. Of course, no disaster is that elementary or straight forward, but each bears similarities regarding the effects of disasters and the requirements for response.

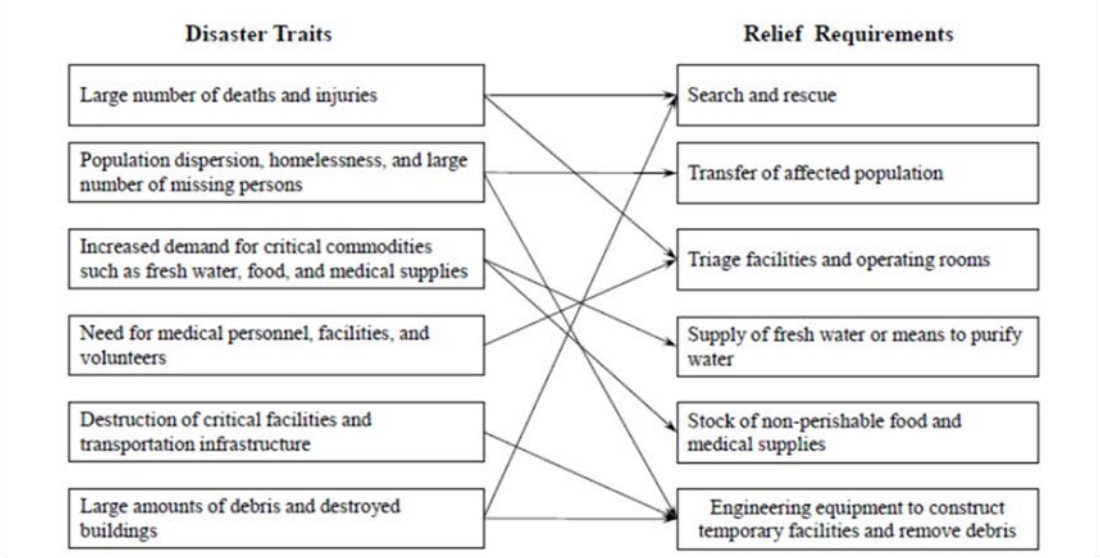


Figure 2. Basic Disaster Traits and Relief Requirements

Source: Aruna Apte, Keenan D. Yoho, Cullen M. Greenfield, and Cameron A. Ingram, "Selecting Maritime Disaster Response Capabilities," *Journal of Operations and Supply Chain Management* 6, no. 2 (2013): 46.

Logistics—Supply Chain Integration and Organizational Effectiveness

Several pieces of work use the term logistics interchangeably with supply chain management. Thus the scope was broadened to include literature on supply chain management. In this study, supply chain refers to "inbound and outbound transportation, warehousing, and inventory control, sourcing, procurement, and supply management forecasting, production planning and scheduling, order processing, and customer service all are part of the process as well. It also embodies the information systems" (Zigiaris 2000, 2). Most definitions of supply chain management "explicitly recognize the existence of two flows through the chain; there is a flow of goods and an equally

important flow of information" (Fisher 1997, Pagell 2004, as cited in Prajogo and Olhager 2009, 2).

Supply Chain Integration

Supply chain integration involves communication and effective inclusion of all parties along the entire chain. This integration includes supplier involvement. However, according to Ramsden (2014, 63), "in most supply chains, 90% of relationships are transactional . . . there is very little trust and very little ability to innovate together (with suppliers)." Integrated logistics tends to promote more reliable order cycles and predictive supply to end users and customers. Several studies in the past have looked at various aspects of supply chain management (SCM) performance and have noted the importance of supply chain integration. This integration entailed efficient management of information and close collaboration amongst organizations along the supply chain (Bagchi and Skjoett-Larsen 2003; Fawcett and Magnan 2002; Frohlich and Westbrook 2001; McAdam and McCormack 2001; Olhager and Selldin 2003; Ragatz et al. 1997 quoted in Alam et al. 2014, 554). The results on the link between integration and performance are, however, inconsistent with prior research. Some research indicates successful integration as a major factor to produce efficient logistics operations (Closs and Savitskie 2003; Tan 2002; Daugherty et al. 1996 quoted in Alam et al. 2014, 554). While others suggest the opposite (Stank et al. 2001a; Swink et al. 2007; Fawcett and Magnan 2002 quoted in Alam et al. 2014, 554). This evidence raises questions about the viability and utility of an integrated supply chain in practice (Alam et al. 2014, 554).

Logistics Performance Management

Organizations often do not measure the effectiveness of the improvement strategies implemented. The chance exists that where there are improvements, that they may be attributable to some other factor and not necessarily the improvement tool. Graeml et al.(2011, 2) suggest that even though logistics has gained recent organizational attention, the development of specific tools to evaluate and assess the effectiveness of the logistics performance and academic research about the issue are still scarce. One cannot manage something that cannot be measured, so the first task would be to decide on the most effective tool to measure its effectiveness. Keebler and Durtsche (1999) conducted research to determine the effectiveness of a tool in assessing logistics effectiveness on businesses in Brazil. The research found that there was little chance for suppliers to satisfy customers' expectations where there was no clear definition and agreement of quality, value, effectiveness and efficiency. The study determined that where customers and suppliers do not agree on what to measure, then evaluation and improvement of logistics performance becomes very difficult.

Recent research has identified that there are three key processes to consider when assessing elements of the supply chain. Keebler and Durtsche (1999) identify order fulfillment, sourcing—procurement, and planning—forecasting—scheduling as the main determinants. These shared processes between customer and supplier when measured may assist to determine logistics effectiveness. They can be further broken down to the measurement of "on-time delivery, order fill, line item fit, back-order, order cycle time, invoice accuracy, case fill, over/short, costs, response time and accuracy" (Keebler and Durtsche 1999). When ranked according to perceived importance, both customer and

supplier viewed the measurements differently. As such, to achieve excellence in logistics, organizations must ensure that they align logistics processes with the organization's strategy.

Commercial supply chains tend to employ collaborative techniques to ensure efficiency. However, humanitarian relief chains do not possess the collaborative practices characteristic of commercial supply chains. Further, ineffective coordination amongst relief actors, the affected country, "suppliers, logistics servers, and demanders is still a major concern" (Day et al. 2012; Heaslip 2012a, 2011 and 2010; Carroll and Neu 2009; Tomasini and van Wassenhove 2009) cited in Ramsden 2014, 2).

Pritchett Woolcock, and Andrews (2010, 33) speak about the capability trap where low capability and high work pressure gets embedded in the organization's culture. The organization becomes dependent on firefighting and working harder to solve problems caused by inefficiencies and low capability instead of proper systems. As public spenders, TTDF is severely constrained by this ineffective legislative approach and has not been able to incorporate emerging technologies in procurement such as e-tendering, reverse tendering and e-procurement. The system is paper-based and as such is man-power intensive, tedious, slow and ineffective. To reduce discretion, a request to purchase an item must go through at least five levels of checks, signatures, and approvals. For the process to remain efficient, there must be a balanced approach to reduce discretion while still enabling an efficient process. The author and a group of TTDF officers mapped out all the processes required for the procurement of an item of supply. This mapping process yielded a process map with more than a hundred steps from the identification of the need, to the item delivered to the customer. More than 50 percent of

the process was outside the remit of the TTDF's control and lay within the powers of the public procurement system. Therefore, there is a requirement to review the system of acquisition so that it can be more responsive during times of crisis when time is of the essence.

What is Military Effectiveness and how is it Measured?

Military Effectiveness

Experience has shown that militaries have resources that specifically qualify them for disaster response; human resources, equipment, ability to operate in austere environments and self-sustainability. According to Millett, Murray, and Watman (1986, 37), military effectiveness is the process by which armed forces convert resources into fighting power. An effective military is one that can convert the resources at its disposal into an organization capable of conducting operations against a broad range of adversaries, (Tellis et al. 2000, 36). According to Millett, Murray, and Watman (1986, 45), military effectiveness assessment occurs at each level of activity: political, strategic, operational and tactical. Although each level of activity may overlap, what constitutes effectiveness at each level may conflict with what constitutes effectiveness at the other levels. Increased effectiveness at one level of military operations may cause inefficiencies at another level. However, there will, of course, be similarities amongst all levels. Alignment of resources enables political-military effectiveness. The military, like all other public institutions, must compete for a piece of the "public pie" for expenditure. Millett, Murray, and Watman (1986, 46), argue that a military organization's political effectiveness depends on an ability to articulate its needs more persuasively than its competitors do. Critical to this is the extent to which the political elite regard the military

as legitimate and officership as a distinct profession requiring specialized training and extensive education. Although they are improving, humanitarian supply chains are “less efficient and the people running them less well trained than their commercial and military counterparts” (Beisner 2010).

Military effectiveness at the strategic level is the ability of the armed forces to achieve the political objectives with force or other elements of the national power (Diplomacy, Information, Military, Economic). The military must effectively communicate what is strategically possible based on the military capability to the political hierarchy. Political goals that are not strategically possible are futile and often result in misalignment of efforts. The operational level of military effectiveness involves the analysis, selection, and development of institutional concepts or doctrine to employ military forces to achieve strategic objectives. At the operational level, there is analysis, planning, preparation, and conduct of military campaigns sometimes at the theater level. Matters at the operational level include the disposition and marshaling of military units, selection of theater objectives, an organization of logistical support, and the direction of ground, air and sea forces. The tactical level of military effectiveness refers to the specific techniques used by combat units to fight engagements to achieve operational objectives. These actions include logistical arrangements in support of military engagements. The line between operational and tactical levels is usually blurred. Strategic objectives should be shaped by what is tactically feasible and achievable. So, a TTDF Government mandate to provide national and regional disaster response must be supported by policy and capacity to enable this response. For a tactical system to be considered effective, there must be integration across all arms, with consideration given

to terrain, training, troop quality, and troop morale as well as other relevant variables, Millett, Murray, and Watman (1986, 62).

What does Literature say about the Roles of the Military for Disaster Relief Operations?

HADR Assistance

Guidelines for the Use of Military and Civil Defence Assets in Disaster Relief (Oslo Guidelines) created by United Nations Office for Coordination of Humanitarian Affairs (UNOCHA) in 1994 identify the use of the military facilities and capacities of foreign militaries as a means of "last resort." Therefore, military and civil defense assets are necessary where there is no alternative organization with the required capability (Wiharta et al. 2008,11). The humanitarian community is critical of the growing encroachment of military actors into humanitarian operations (Metcalfe 2012, 1). Some in the humanitarian community argue that just because the military can perform a task, it may not necessarily be the most appropriate entity to do so since most militaries do not train their personnel in the principles and practices of humanitarian affairs.

Kapucu (2011, 8) argues that the use of military assets is an expected response to large-scale disasters. Schrader (1993) in Kapucu (2011, 8) defined three response sectors that the military is especially capable of assuming during a disaster mission:

1. Special skills corresponding to assistance of response operations;
2. Communication for disaster command and control; and
3. Organized forces providing general support in some actions.

Additionally, Kapucu (2011, 9) intimated that the military usually possesses or has access to cutting edge technology and trained personnel, improving communication

capability. During disasters, military forces can bring with them specialized workforce, skills, expertise, rapid strategic mobilization, technological solutions, and equipment (helicopters, aircraft, earth-moving machinery, respirators, medical supplies, power, and lighting equipment, and water production capability) that most emergency organizations are unable to acquire. Additionally, the military hierarchical and autonomous structure lends to effective command, coordination, and control of workforce, authority, and regulations, which are necessary for effective disaster response (Anderson 1970; Schrader 1993; Sylves 2008; US House of Representatives 2006 cited in Kapucu 2011, 9). The military can also assist in providing shelter for affected persons, the construction of temporary housing and restoration of basic critical infrastructure (water, electric, sanitation, and communication infrastructure) (Miskel 2006; Schrader 1993 cited in Kapucu 2011, 9).

Fischer (2011) said that based on international experience, New Zealand's Defence Minister Wayne Mapp observed that major disasters quickly overwhelm local emergency services. Mr. Mapp proposed that humanitarian relief should be a core task for all defense forces, particularly Asia-Pacific militaries. The principal responsibility for disaster response rests with civilian agencies at local, state and federal levels; however, only the military has the workforce, equipment, training and organization to respond to catastrophes. Nonetheless, in recognition of the fact that humanitarian relief should continue to be a predominantly civilian function, international organizations place limitations on the use of foreign military assets as a last resort.

This thesis expands on research conducted by Colonel George Robinson (Ret'd TTDF) when he was a student at the Command and General Staff School in 2004. He

posited that there was an increased role for the armed forces of the Caribbean in managing the response to hurricanes (Robinson 2004, 11). The research conducted was limited to hurricane response since before the 2010 earthquake in Haiti, Caribbean disaster response was primarily for hurricane relief. Robinson (2004, 57) indicated that Caribbean countries are incapable of responding to disasters nationally or regionally without foreign assistance. Additionally, he stated that individual Caribbean forces have different command and control systems, terminology, doctrine, and operating standards. Therefore, regional response and integration were and still are difficult due to differences in equipment and operating standards. Today there is still no standardization across regional militaries. Robinson (2004, 55) in his analysis said that the Caribbean Disaster and Emergency Relief Agency (CDERA, now called CDEMA) agreement describes soldiers and police officers as a homogeneous entity. This generic categorization adds theoretically to the difficulty with command and control of execution as two diverse organizations are organized to conduct the same task. The two organizations, with differing doctrine and mandates, can be incompatible when it matters most in times of crisis.

Robinson (2004, 27) indicated that his research pointed to an insufficient study on initiatives being undertaken by the Caribbean to improve local and regional response. However, there is now an abundance of literature investigating actions taken by the international community to assist the region. His thesis concluded that there is an urgent role for the armed forces of the Caribbean in hurricane relief operations and recommended policy changes to improve national and regional response. Robinson also spoke about his experience where soldiers from participating CARICOM countries

arrived in a devastated country to provide aid but were without shelter, food or the bare essentials for their self-sustainment. Thus the regional response, while welcomed, placed a burden on the disaster-afflicted country and on the international responders to sustain them as well as the afflicted nation. The Commander of Southern Command (SOUTHCOM) suggested that an important role for his institution is to respond to regional disasters and crises and assist countries with development of their capability to address security challenges of the 21st century (Ferdinando 2017).

According to Stuart and Johnson (2011, 66), the Air Force has personnel assigned to dedicated disaster response teams. These teams are prepared for rapid deployment and train together, prepared for these potential disasters. They are therefore specially trained, equipped and prepared for disaster response. Yoshizaki (undated) said that the military employment as last resort for disaster relief is reasonable, but it can become the first responder since inherent within the military is superior mobility and the ability to set up critical infrastructures.

Similarly, Wiharta et al. (2008, 14) indicated that the Japan Self Defence Force (SDF) considers disaster relief operations as standard activities despite the fact HA—DR operations are more commonly a “non-traditional military mission.” The SDF has a long history of carrying out disaster relief missions based on three principles—“contribution to the common good, urgency, and no comparable civilian alternatives—which fostered its organizational culture” of serving the residents (Yoshizaki et al. 2006, 87).

An assessment of lessons learned from the response to the humanitarian efforts by the United States (US) Army in Pakistan in 2007, identified several major elements that contributed to its success. These factors included:

1. Speed and effectiveness of the response;

2. Resourcefulness and flexibility including command and control;

3. The ability to coordinate the response to a dynamic and evolving situation, among vastly different military, civilian, and government entities in addition to international nongovernmental organizations (NGOs);

4. Creating a "semi-permissive" environment;

5. The prominence of strategic public affairs/public diplomacy and the way they enhanced U.S. goals in the US CENTRAL COMMAND (USCENTCOM) area of responsibility (AOR); and

6. A major factor in mission success was the relationship with the host nation military. (Brathwaite 2007, 20)

The military's rapid initial response brought a sense of order to the affected areas in Pakistan. The Pakistan Army established command and control and created a semi-permissive environment. The military enabled further assistance by providing access to populations cut off by the disaster. They secured landing zones, established a communication and logistics network and provided reassurance to the population. "In a complex humanitarian disaster like the South Asia earthquake, an empowered on-scene commander directing the evolving situation was critical. The portability and capacity of the military assets were vital to the timeliness of the response" (Brathwaite 2007, 20).

What Role does TTDF Play in Disaster Relief?

TTDF Perceived Role in HADR

Trinidad and Tobago NRF states the following humanitarian and disaster relief roles for TTDF:

> The four formations of the Trinidad and Tobago Defence Force–Regiment, Coast Guard, Air Guard and Reserves–together contribute land, sea and air capabilities to the Force's response efforts. Some roles include damage assessment, search, and rescue, security/crowd control, relief supply distribution, and hazardous material handling. Among these, GORTT mandates the First

Engineer Battalion of the Regiment to work directly with the ODPM in times of emergency. According to the NRF, the Battalion's functions include:

1. Assisting the Trinidad and Tobago Fire Service (TTFS) and Trinidad and Tobago Police Service (TTPS) with search and rescue operations, and TTPS with law enforcement, during an emergency above Level 1.

2. Assisting the Ministry of the People and Social Development (MOPSD) to provide mass care services such as shelter, food and first aid.

3. Assisting the Ministry of Local Government (MOLG) Disaster Management Unit (DMU) and the ODPM with damage and needs assessments after an incident.

4. Assisting the MOPSD with the collection, analysis, and dissemination of information in order to facilitate the overall provision of services and resources during an emergency or disaster." (Office of Disaster Preparedness and Management 2010)

A Cabinet Minute expanded the role of the Engineer Battalion to provide more specific support for the needs of the ODPM. When operationalized for disaster relief, the Engineer Battalion becomes the Operational Arm of the ODPM. The TTDF has responded to all the main natural disaster incidents in Trinidad and Tobago over the last decade. Additionally, the TTDF has responded to numerous disaster affected Island States within the region. These include Grenada-Hurricane Ivan 2004, St Lucia and St Vincent 2013, and Dominica 2015.

TTDF Integration with ODPM and CDEMA

Development Assistance and Civil Defence Operations addresses the strategic priority of humanitarian and disaster relief support to the national efforts of the Office of Disaster Preparedness and Management (ODPM) and regional efforts of the CDEMA. The Office of Disaster Preparedness and Management (ODPM) NRF indicates that TTDF will be called on to collaborate with other national first responders to assist impacted

citizens. The four formations of the Trinidad and Tobago Defence Force–Regiment, Coast Guard, Air Guard and Reserves together contribute land, sea and air capabilities to the Force's response efforts. Among these, the First Engineer Battalion of the Regiment is mandated by Government to work directly with the ODPM in times of emergency. These functions have already been laid out previously as stated in the NRF.

The National Emergency Operations Center (NEOC) managed by the ODPM is established to coordinate the state response to any incident affecting T&T in keeping with the National Response Framework. The NEOC operates on the ICS structure using Emergency Support Functions of which the TTDF is one. National emergency drills and exercises are carried out in concert with first responders and support agencies inclusive of Emergency Support Functions. The National Disaster Risk Reduction Committee was established to address disaster risk, and the TTDF is a member of the response committee. The ODPM has provided training to the TTDF in Shelter Management, EOC operations, damage assessment and needs analysis, and initial damage assessment, just to name a few. The ODPM has also purchased equipment that can be used by the Engineer Battalion to aid in its execution of disaster response.

The CARICOM has mandated that Trinidad and Tobago has oversight and response capabilities to assist islands in the southern and eastern Caribbean (CDERA 2010, 7). During the months of the hurricane season, the Engineer Battalion activates its disaster response element which is on alert for emergency response should the need arise locally or regionally. The Engineer Battalion is equipped to provide humanitarian and disaster relief assistance in the aftermath of a natural disaster. They can produce limited

vertical and horizontal construction as well as flood and other damage assessment and relief.

There was very limited TTDF literature to support this research or direct it. However, there are studies on logistics systems and the correlation between logistics integration and effectiveness in humanitarian and disaster relief operations available for evaluation.

What do the Case Studies tell us?

This research examined four case studies of past natural disasters that occurred in the Western Hemisphere.

Hurricane Ivan 2004–Grenada

Hurricane Ivan struck Grenada on 7 September 2004, as a category three storm (see Appendix A). The World Bank (2004, 7) indicated that Hurricane Ivan destroyed the entire banana, sugarcane, and nutmeg crops, and 70 percent of the tourism infrastructure in Grenada. Ivan destroyed public infrastructure including the nation's second largest hospital 70 percent destroyed, police stations, fire stations and the prison. Damage estimates at over US$800 million or twice Grenada's Gross Domestic Product (GDP) (World Bank 2005, 1). TTDF formed the bulk of the Joint Support Group contributing more than 150 troops to the response effort. TTDF assisted with transportation of 1,276 tons of food and water along with 638 tons of construction material to Grenada (Badri-Maharaj 2012, 6).

Hurricane Katrina 2005–USA

Hurricane Katrina was a Category 3 storm (see Appendix A) when it made landfall on the coast of Louisiana and Mississippi on 29 August 2005. This storm wreaked havoc with 1,836 persons killed, 705 people reported as still missing, 300,000 homes destroyed, and 80 percent of New Orleans submerged under water (Jorgenson 2011, 3). USNORTHCOM established and activated JTF-Katrina to provide military forces to support the relief effort (Inspector General 2006, 6). Local responders were quickly overwhelmed by the magnitude of the floods, lawlessness, and loss of life. During Hurricane Katrina, the local, state, and federal organizations did not have the individual capacities to provide human power, technology, and resources with the strict command and coordination structures that the military is capable of providing (Anderson 1970; Brake 2001; US House of Representatives 2006 cited in Kapucu 2011, 9).

Earthquake 2010–Haiti

On 12 January 12 2010, Haiti suffered a 7.0 magnitude earthquake (see Appendix B). The earthquake killed more than 316,000 people including the head of mission of the United Nations Stabilization Mission in Haiti (MINUSTAH) and his deputy, injured 300,000 others, and displaced more than 1 million people (Cecchine et al. 2013, 1). It claimed the lives of numerous government officials and employees, collapsed 100,000 structures, damaged 200,000 more, destroyed the presidential palace, and demolished 14 out of 16 government ministries. SOUTHCOM created Joint Task Force-Haiti (JTF-H) which carried out Operation Unified Response in concert with MINUSTAH and by 1 February 2010, JTF-H consisted of over 22,000 US service members, 58 aircraft, and 23 ships (Keen et al. 2010, 85).

Hurricane Matthew 2016–Haiti

Hurricane Matthew made landfall in Haiti on 4 October as a Category 4 storm. This storm was the most intense storm ever recorded at this latitude in the Atlantic Basin; just 3°N of Trinidad, surpassing Hurricane Ivan in 2004. Official reports from the Government of Haiti and the United States Agency for International Development (USAID) indicated that heavy rainfall across most of the country resulted in widespread flash flooding, river floods, and mudslides (Stewart 2017, 13). According to Stewart (2017, 12), Hurricane Matthew was liable for 546 deaths in Haiti, an additional 128 persons missing, 439 persons injured and 340,000 people evacuated from their homes. Matthew destroyed 90 percent of structures along the coast. SOUTHCOM responded and stood up Joint Task Force-Matthew (JTF-M). JTF-M eventually ramped up to more than 200 Soldiers, Airmen and Marines from Joint Task Force-Bravo (JTF-B), and Special Purpose Marine Air Ground Task Force South (SPMAGTF) personnel.

These cases are relevant due to their proximity to Trinidad and Tobago in the Caribbean and one in the Gulf region in the USA. There are similarities in size, culture, threats, and economy amongst the island nations of the Caribbean. TTDF provided assistance in Grenada in 2004 and Haiti in 1994. The US military was one of the main contributors to the response efforts in the other three disasters.

Summary and Conclusions

There are restrictions on military response both nationally and internationally to disasters. These restrict the use of military forces as first responders to natural disasters. This literature review has shown that civil organizations charged with disaster response are often negatively affected themselves by the disasters or are very quickly

overwhelmed. The military is then called out with the expectation that they can perform and save lives and property where civil organizations are limited. Previous researchers have outlined the capabilities that are usually inherent within militaries that predispose them for efficiency and self-sufficiency which make them ideally suited to respond to disasters which often occur with little to no warning and with devastating effects on population and infrastructure.

Success along the HA supply chain is measured to ascertain whether the response is sufficient or whether there are further improvements to be made. Various authors have indicated that measures include cost, on-time delivery, order fill, line item fit, back-order, order cycle time, invoice accuracy, case fill, over—short, response time and accuracy.

The literature review shows that there is an emergent realization of a need for a more significant role and, based on the situation, earlier injection of militaries in response to disasters. The Oslo Guidelines (2007) limit foreign military involvement to last resort, but quite often, by this time there has already been a significant loss of life and property as well as diminishing returns from civilian responders. Legal limitations also shroud the National military response which must be unraveled long before the onset of a disaster. There are at least two main schools of thought: those for an increased role for the military in disaster relief efforts and those for limiting military involvement.

The remainder of this thesis consists of three chapters. Chapter 3 describes the methodology used for the research and analysis of this study. Chapter 4 lays out the data analyzed using the methodology described in chapter 3. Chapter 5 is the last chapter of the study and presents the conclusions garnered from the analysis as well as recommendations for further research and implementation.

CHAPTER 3

RESEARCH METHODOLOGY

Introduction

The purpose of this study was to investigate the TTDF's role and readiness in disaster response. This chapter consists of four major parts. First, this chapter discusses the chosen research methodology used in this research process, and then the reasons for choosing this method are identified. Thirdly, the collection of data is explained to show how the researcher manages the cases, and the final section discusses how the data are analyzed using qualitative measurement.

Methodology

This research was conducted using a case study methodology comparing four cases against six criteria. This methodology is a social constructionist (Saunders, Lewis, and Thornhill 2012) view where customer service in an organization has a separate reality from the customers who perceive that reality. This research is therefore designed around a functionalist paradigm (Saunders, Lewis, and Thornhill 2012), which predisposes a researcher to look at why organizational problems are occurring and develop solutions within the boundaries of the organizational construct.

To determine where gaps exist in the TTDF response to disasters and where this can be improved, the author conducted a comparison of case studies and evaluation of what others have written about a military response to natural disasters. The comparison of case studies highlighted similarities and dissimilarities which, when further

deconstructed, showed where lessons could be learned and improvements recommended for the TTDF approach.

Feasibility of Method

This chosen methodology is traditionally suited to answering the "How?" and "Why?" questions, and thus applicable for exploratory, descriptive or explanatory research (Rowley 2002, 16). Case studies provide a deeper, more detailed analysis necessary to answer these questions. Eisenhardt (1989) in Rowley (2002, 16), affirmed the use of case studies for research where there appears to be limited theory on the topic. This limitation justifies the case study methodology. While HADR operations requiring a military response is not a new phenomenon, there seems to be an increased interest in the TTDF's roles and its capability to conduct humanitarian and disaster relief operations. Research, though existing sources are limited, is required.

The concept of an impartial researcher has already been discredited by Van de Ven and Poole (2004). As such, the author's research is tainted by preconceived notions and past experiences and must be considered in the research design to achieve any degree of impartiality. Similarly, case studies are tainted by the authors' opinions. However, case studies allow the researcher to investigate a subject in the context of its surroundings thereby negating the requirements for replicating in a laboratory or an experimental setting.

Research Design

The research takes a positivist and deductive approach to case study design. The definition of questions and propositions are conceived before the collection of data.

According to Rowley (2002, 18), this positivist approach allows a new researcher a straight forward and simple path to meaningful research. The researcher can better manage and understand issues such as validity and reliability, and structure data collected and analyzed during the research process. In selecting the research design for this paper, consideration of the essence of the problem to be answered gave the study perspective.

This study seeks to answer the primary research question: "What gaps exist in the ability of the TTDF to provide logistics support in response to Humanitarian Assistance and Disaster Relief operations?"

The secondary questions are:

1. What is the role of the TTDF in disaster relief and humanitarian assistance?
2. What constitutes sufficient preparedness for a potential disaster?
3. How well can TTDF respond to disaster relief requirements?
4. How well does TTDF integrate with the Office of Disaster Preparedness and Management (ODPM) and Caribbean Disaster and Emergency Management Agency (CDEMA)?

The tertiary questions are:

1. What lessons learned emerge from case studies?
2. What do recent case studies say about TTDF's ability to respond to disaster relief requirements?
3. How much capability is enough and is an increase required?
4. How could improved integration increase capability?
5. Does improved HADR capability improve overall TTDF capabilities?

This study examined four case studies of past natural disasters that occurred in the Western Hemisphere: Hurricane Ivan 2004–Grenada, Hurricane Katrina 2005–USA, Earthquake 2010–Haiti, and Hurricane Matthew 2016–Haiti. These cases are relevant due to their proximity to Trinidad and Tobago. Three of the cases occurred in the Caribbean and one in the Gulf region in the USA. There are similarities in size, culture, threats, and economy amongst the island nations of the Caribbean. Additionally, regional cooperation facilitates the provision of aid in times of disaster throughout the Caribbean. TTDF provided assistance in Grenada in 2004 and Haiti in 1994. Further, the US military was the main contributor to the response efforts in these disasters, and through Southcom and other partnership initiatives, there is cooperation in disaster mitigation, preparation, and relief. Due to the US being one of the main responders, there is sufficient published literature to enable a successful analysis despite the lack of TTDF data.

Hammersley and Atkinson (1983) suggest that the researcher as an ethnographer should attempt to understand the effects of the field role upon subjects in the research setting. Bechhofer (1974, 73) in Gill and Johnson (2005), remind us that the research process is not as clear-cut as we would like it; rather it is a constant interaction between conceptual and empirical, deduction and induction. This fact suggests that the researcher must be flexible and intuitive to adapt as necessary. The author has therefore tried to be flexible and not be tied down by prejudiced notions but rather allow the research to lead to a solution.

According to Gill and Johnson (2005), all research approaches may have something to offer, and there is no independent form of evaluating different research strategies in absolute terms. Similarly, McGrath (1982) aptly uses the term dilemmatic to

describe the study of research choices, in which it is clear there are no ideal solutions only a series of compromises. Therefore, this research is designed to capitalize on the cohesiveness between these theories in the context of the case study of TTDF.

Sources of Data

Information to answer the research questions emanated through an examination of primary and secondary data, resources written by other authors. The research data involves news articles, magazine articles, UN reports, CDEMA reports Office of Foreign Disaster Assistance (OFDA) and USAID) reports and other US Government sources. These resources have been acquired from online searches as well as through the Combined Arms Research Library.

Data Analysis

This research paper used a theoretical sampling methodology. The samples or case studies chosen were those that appeared to best answer the research questions. The data relevant to each case study considered the context of military response and the lessons learned. Commonalities across all cases emerge amongst those affected populations' regarding requirements after a disaster. The similarity reinforces the validity and reliability of the measures used. Apte et al. (2013, 46), identified six basic traits associated with the results of disasters and the corresponding relief requirements based on the presence of the trait. He identified the disaster traits as:

1. Large number of deaths and injuries–require search and rescue, triage facilities and operating rooms;

2. Population dispersion, homelessness, and large number of missing persons–require transfer of affected persons, engineers to construct temporary shelters and remove debris;

3. Increased demand for critical commodities such as fresh water, food, and medical supplies–require fresh water or means to purify water, non-perishable food, and medical supplies;

4. Medical personnel, facilities, and volunteers–require triage facility and operating rooms;

5. Destruction of critical facilities and transportation infrastructure–require engineers to construct temporary shelters and remove debris; and

6. Large amounts of debris and destroyed buildings–require engineers and search and rescue (Apte et al. 2013, 46).

Apte's traits were used to distinguish some of the six criterion developed by the author against the case studies. These cases may or may not possess similarities in the TTDF's operating environment but the factors examined will be common so that there can be some extrapolation of results. The parameter of the study has been limited to the investigation of these four cases against six criteria to make the study manageable. These included:

1. The magnitude of the storm and its effect;

2. What constituted the national response;

3. Who responded;

4. The elements of success of the response effort;

5. The critical elements provided by the military; and

6. The ability of the nation to provide relief and enable international military response if unable to solve its problems independently (see table 1).

Table 1 Elements of Cases

ITEM NO	ELEMENTS	Hurricane IVAN Grenada 2004	Hurricane KATRINA USA 2005	EARTHQUAKE HAITI 2010	Hurricane MATHEW Haiti 2016
1	Magnitude of storm and effect				
2	National response				
3	Who responded				
4	Elements of success				
5	Critical elements provided by military				
6	Ability of nation to provide relief/enable international military response				

Source: Created by author.

The first element is the magnitude of the storm and its effect. This criterion identified the size of the disaster when it struck and the quantification and qualification of its most significant effects on the country. This criterion included the amount of damage as a percentage of GDP and the general impact on the economy. The number of lives lost, persons injured and persons displaced, and any other impacts that can be attributed to the disaster and included under this criterion. This element can be linked to elements 1, 2, 5, and 6, of Apte's disaster traits. He identified that requirements include search and rescue, triage facilities and operating rooms, transfer of affected persons, and engineers to

construct temporary shelters and remove debris. Therefore, examination of the cases may identify similar requirements and whether the military provided them.

The second element used to distinguish the case studies was the national response of the affected country. This criterion examined what the affected country did in response to the disaster. This criterion identified whether the country declared a national disaster which enabled escalation to be a federal and international response. The effectiveness of response was whether the country was able to provide relief without military assistance.

The third criterion examined "Who responded" to the disaster. This criterion looked at whether the response was purely civilian or whether military forces were employed. The fourth criterion reviewed the elements of success in the response effort. It looked at what the requirements were, and if this is provided, and by whom. Further to the achievements, the fifth criterion examined the elements furnished by the military. If determined that the military responded, this criterion looks at the unique elements delivered by the military that civilians were unable to provide without the military. This criterion links to the six relief requirements identified by Apte to determine if the military met their demands. The last criterion examined the ability of the nation to provide relief. This criterion also reviewed whether that nation had the governance, command, and control, and local capability to provide basic support to facilitate federal or international assistance.

The data obtained from the four cases across the six criteria looks to reveal common trends and similarities which indicate areas of commonality amongst the four cases of military disaster response. These similarities in military disaster response extrapolate into lessons learned for TTDF disaster response. The data obtained from the

cases were then used to answer tertiary, secondary and the primary question of this study, where are the gaps between roles and capability in TTDF disaster response.

Summary and Conclusion

This research paper used a theoretical sampling methodology through case study analysis. Four natural disaster cases were examined against six criteria: Hurricane Ivan in Grenada, 2004; Hurricane Katrina in USA, 2005; Haiti earthquake, 2010; Hurricane Matthew in Haiti, 2016. The six criteria were:

1. Magnitude of the storm and its effect;
2. National response;
3. Who responded;
4. Elements of success;
5. Critical elements provided by military; and
6. The ability of the nation to provide relief and enable international assistance.

Chapter 4 lays out the data analyzed using the methodology described in chapter 3. Chapter 5 presents the conclusions garnered from the analysis as well as recommendations for further research and implementation.

CHAPTER 4

ANALYSIS

Introduction

The purpose of this study was to investigate the TTDF's role and readiness for disaster response. Conclusions were drawn from an examination of case studies to answer the questions laid out in this thesis. This chapter answered each research question based on the analysis of the cases in the context of the six factors drawn from the four cases based on existing literature. The case studies analyzed were Hurricane Ivan in Grenada in 2004, Hurricane Katrina in Louisiana, the USA in 2005, Haiti earthquake in 2010 and Hurricane Matthew in Haiti 2016. These four case studies examined the disasters to note the occurrence and meaning of the six criteria. These criteria included:

1. The magnitude of the storm and its effect;
2. What constituted the national response;
3. The responders;
4. The elements of success of the response effort;
5. The critical elements provided by the military; and
6. The ability of the affected nation to respond and if unable, then to enable an international military response.

This chapter presents each case in detail against these six criteria.

This study seeks to respond to the primary question: "What gaps exist in the ability of the TTDF to provide logistics support in response to Humanitarian Assistance and Disaster Relief Operations?"

The secondary questions are:

1. What is the role of the TTDF in disaster relief and humanitarian assistance?
2. What constitutes sufficient preparedness for a potential disaster?
3. How well can TTDF respond to disaster relief requirements?
4. How well does TTDF integrate with the Office of Disaster Preparedness and Management (ODPM) and Caribbean Disaster and Emergency Management Agency (CDEMA)?

The tertiary questions are:

1. What lessons learned emerge from case studies?
2. What do recent case studies say about TTDF's ability to respond to disaster relief requirements?
3. How much capability is enough and is an increase required?
4. How could improved integration increase capability?
5. Does improved HADR capability improve overall TTDF capabilities?

Case Studies

Hurricane Ivan, Grenada, 2004

The first case investigated was Hurricane Ivan which occurred in 2004 and affected the island of Grenada (see table 2). Hurricane Ivan struck Grenada on 7 September 2004, as a category three storm (see Appendix A). Many buildings such as the national stadium, the prison, homes and government buildings were destroyed, including the residence of the prime minister.

Damage estimates at over US$800 million or twice Grenada's Gross Domestic Product (GDP) (World Bank 2005, 1). The entire island was affected but, the storm

hardest hit the southern end of Grenada. The eye wall section of the hurricane inundated that part of the island (World Bank 2004, 2). The southern part of Grenada was exposed to severe winds of more than 135 mph and experienced the most damage. The fact that the storm passed over during the day and brought limited rainfall, somewhat mitigated the damages (World Bank 2004, 2). Although there was little damage caused by flooding, the storm left 39 people dead in its wake and a devastated economy.

The storm destroyed the entire banana, sugarcane, and nutmeg crops, and 70 percent of the tourism infrastructure. Ivan destroyed public infrastructure including the nation's second largest hospital 70 percent destroyed, police stations, fire stations and the prison. Two out of 75 schools were undamaged. Roadways remained intact although debris and fallen trees blocked some. Ivan affected the electrical distribution network and communications grid. "The water distribution system was only partially affected. Airport and port facilities suffered damages but were nearly 100% functional" (World Bank 2004, 7).

Out of all the Caribbean islands affected by Hurricane Ivan, Grenada was the most devastated. Prime Minister Mitchell declared a state of emergency to control the movement of more than 250 escaped prisoners due to the destruction of the Richmond Hill Prison. Grenada's security forces were affected themselves with homes and police stations damaged or destroyed thus they could barely assist themselves. There was a requirement for facilities for families of first responders so that they could focus on the relief effort. Food and medical aid were assembled through various aid agencies and brought in by boat to the capital, St Georges. The US Government declared Grenada a

disaster area, initiating US emergency relief for the island. International assistance mobilized almost immediately.

Within two days, relief teams and supplies were arriving on the island. CARICOM troops from Trinidad and Tobago, Barbados, Antigua and St Kitts Defence Forces deployed to assist Grenada in securing buildings, as there was widespread panic and looting by residents for food, water, and gasoline (World Bank 2005, 9; Badri-Maharaj 2012, 6). Caribbean Disaster Emergency Response Agency (CDERA, now called CDEMA) played a major role in coordinating relief with international relief agencies such as PAHO, the Red Cross, OXFAM, and USAID.

Trinidad and Tobago Defence Force as the SRFP for the region was in Grenada at least 48 hours before any other responders. The TTDF's main tasks were initial damage assessment, help recapture escaped prisoners, provide security, aid with the distribution of supplies, and aid in reconstruction efforts. TTDF formed the bulk of the Joint Support Group contributing more than 150 troops to the response effort. TTDF assisted with transportation of 1,276 tons of food and water along with 638 tons of construction material to Grenada. TTDF was a vital player in the restoration of law, order and civic assistance to the Grenadians. The Trinidad and Tobago Air Guard (TTAG) provided transportation, aerial reconnaissance and search and rescue. The Trinidad and Tobago Coast Guard (TTCG) also provided transport of food, water, medical assistance and construction material from Trinidad as well as management of the seaport. The relief provided proved invaluable to the affected citizens (Badri-Maharaj 2012, 6).

Grenada was severely affected through widespread damage of infrastructure and economic capacity. Fortunately, there was no excessive loss of life, but particuar to this

situation was the extent that local responders were themselves affected by the disaster. Thirty-nine persons lost their lives, 85 percent of the infrastructure on the island of Grenada destroyed with 100 percent destruction of the banana and nutmeg crop. In this case, the TTDF was able to define initial relief requirements and bridged the gap during the period when communications were damaged. They also enabled a permissive environment through establishing security and assisted in the restoration of law and order, by recapturing escaped prisoners and filling the gap left by local law enforcement who were negatively affected by the storm. TTDF also assisted in search and rescue efforts and medical support. They were also able to self-sustain thus relieving any burden on the Grenadian economy. Inherent in this response was the role that the military played in maintaining communications, security, search and rescue and self-sustainment.

Table 2 Hurricane Ivan, Grenada 2004

ITEM NO	ELEMENTS	Hurricane IVAN Grenada 2004
1	Magnitude of storm and effect	Category 3, mainly wind damage 39 dead, 85% of island infrastructure destroyed, 100% banana and nutmeg crop destroyed, $815 million in damages
2	National response	Declared a national disaster
3	Who responded	USAID, CDERA, TTDF
4	Elements of success	A coordinated regional response, large TTDF presence, International assistance provided for reconstruction
5	Critical elements provided by military	Defined initial requirements, provided limited communications, security, civic assistance and the rule of law, transport, medical support, search and rescue, distribution of supplies, port management, self-sustainment
6	Ability of nation to provide relief/enable international military response	Limited

Source: Created by author.

Katrina 2005

The second case studied was Hurricane Katrina, which affected the USA in 2005 (see table 3). The National Weather Service predicted that after the storm hit, "most of the [Gulf Coast] area will be uninhabitable for weeks . . . perhaps longer" (history.com staff 2009). Hurricane Katrina was a Category 3 (see Appendix A) storm when it made landfall on the coast of Louisiana and Mississippi on 29 August 2005. This storm wreaked havoc with 1,836 persons killed, 705 people reported as still missing, 300,000 homes destroyed, and 80 percent New Orleans submerged under water (Jorgenson

2011, 3). The economies of southern states were also affected by 19 percent reduced oil production (history.com staff 2009) with agriculture and tourism were severely affected. Water damaged roads with entire communities under water and estimated losses amounted to between $96 and $125 billion. The most destruction was as a result of severe flooding when the levees broke on the banks of the Mississippi River. The Governor ordered evacuations, and by 28 August approximately 80 to 90 percent of residents were evacuated before the disaster struck (history.com staff 2009).

Local responders were quickly overwhelmed by the magnitude of the floods, lawlessness, and loss of life. During Hurricane Katrina, the local, state, and federal organizations did not have the individual capacities to provide human power, technology, and resources with the strict command and coordination structures that the military is capable of providing (Anderson 1970; Brake 2001; US House of Representatives 2006 cited in Kapucu 2011, 9). Because many New Orleans police officers simply abandoned their duties, there were insufficient police officers to control the widespread looting and violence that erupted as residents frantically sought to obtain food, water, and other necessities.

United Northern Command established and activated JTF-Katrina to provide military forces to support the relief effort (Inspector General. 2006, 6). By 12 September, there were more than 22,000 Title 10 military and DOD civilians under the command and control of JTF-Katrina. The Defense Logistics Agency and the US Army Materiel Command provided critical logistics, commodities, and equipment support (Inspector General. 2006, 6). National Guard units responded from all 50 States, the District of Columbia, and three US Territories and by 5 September 2005, totaled 50,000 troops. The

US Army Corps of Engineers is the only DoD Component with first responder authority in the National Response Plan (NRP). The Corps of Engineers under Title 33, Public Law 84-99, provided flood control and acted as one of the primary Federal agencies for Public Works, and Engineering (Inspector General. 2006, 7). The Corps of Engineers provided more than 2,800 personnel in the joint operations area.

Overall, once committed, the military's support in Hurricane Katrina was speedy, efficient and critical. The response proved invaluable to the overall response effort (Kapucu 2011, 20). The military filled a significant gap in the relief effort and saved many lives in the long run. The main services and commodities provided by the military according to Kapucu (2011, 26) were:

1. Search and rescue and evacuation;
2. Transport of materials and supplies;
3. Repair to levees and removal of debris;
4. Provision of meals, water, and ice;
5. House-to-house search operations;
6. Medical treatment for affected civilians;
7. Mosquito spraying operations; and
8. Damage assessments of affected areas using reconnaissance aircraft and satellite imagery.

However, there were several challenges in military deployment, mobilization, and response actions. Kapucu (2011, 22) postulated that one of the first factors which jeopardized the response effort was the lack of clarity in the identification of requirements for the military by affected states. State Governors had sent Federal

assistance request letters to the President before the hurricane hit. However, they were unclear and did not state the exact type and quantity of military units required. This lapse in communication delayed the full deployment of troops in support of this disaster.

The Inspector General's report highlighted incomplete plans and procedures for supporting agencies of the National Response Plan when Katrina hit. However, USNORTHCOM provided the requested assistance to the primary Federal agencies with the USNORTHCOM "Civil Support Concept of Employment," still in draft. These supporting plans would have laid out the civil support activities required of USNORTHCOM from the strategic to the tactical level. The absence of policy and procedures contributed to the confusion in the execution of the civil support. Additionally, USNORTHCOM's coordination with the Federal Emergency Management Agency (FEMA) was limited. There was little clarity on the best employment of military assets according to capability and insufficient coordination between the National Guard and Title 10 Forces. USNORTHCOM experienced difficulty coordinating the use of Title 10, Title 32, and State Active Duty forces. Also due to the rapid deployment of troops into the area, Joint Reception, Staging, Onward Movement and Integration proved a challenge. Further, insufficient integration of DOD forces with the Federal response during disasters contributed to coordination problems (Inspector General. 2006, 8).

Both National Guard and Active Duty Forces responded, each with its command structure, equipment, and legal status. Amongst the two types of units, varying equipment caused issues of interoperability. Amongst all the actors in the response, there were even further issues of poor interoperability as different levels of clearance dictated restriction in information sharing. Thus, poor communication became an issue and added confusion

due in part to a flawed common operating picture. The communication infrastructure was affected in Louisiana thereby reducing the ability to communicate amongst all the major players effectively. Variability in equipment further reduced communication. Despite the success of the military response to Katrina, Kapucu (2011, 25) spoke about difficulties with communication between responders during the early days.

There were also lessons to be learned from the local response. Katrina highlighted the need for clear command, control, and coordination of the local response. Local resources are usually the first on the scene and have the most knowledge and information on local areas. Local officials, when they can, should retain command and control for the response, with state officials providing coordination and support, and federal officials providing resource and multi-state coordination (Executive staff of the Louisiana Commission on Law Enforcement 2017, 11). In this case, the local responders were also personally affected by the storm and its aftermath. Katrina showed that first responders function better if their families are safe (Executive staff of the Louisiana Commission on Law Enforcement 2017, 21). Therefore, there must be facilities identified for families of first responders so that they are comfortable that their families are safe.

There were also lessons to be learned from the military response. The National Guard units were more familiar with the cultural and geographic idiosyncrasies of their home states. They also have established formal and informal relationships with community-based and local response authorities such as police, fire service, and other first responders. Thus, Schrader in Kapucu (2011, 23) stated that “to effectively establish the role of the military in disaster response operations, the limits and restrictions of the

military's role need to be explored to eliminate uncertainties, misinterpretation of media and incorrect public criticism in the future."

Finally, there were lessons to be learned for improvement of civil-military coordination in a disaster response. Inspector General (2006) from the DOD Office of the Inspector General laid out specific recommendations for improved integration of Northern Command with the civil authorities in disaster response. These include:

> Planning and coordinating military support to civil authorities;
>
> Developing a plan for the joint reception, staging, onward movement and integration of military forces;
>
> Standardizing interoperable communication architectures;
>
> Coordinating DoD logistics commodity support to the Federal Emergency Management Agency; and
>
> Training and exercising DoD Components and Federal agencies in support of the National Response Plan. (Inspector General 2006)

Table 3 Hurricane Katrina, USA 2005

ITEM NO	ELEMENTS	Hurricane KATRINA, USA 2005
1	Magnitude of storm and effect	Category 3, mainly water damage, 1,836 dead, 19% oil production damaged, agriculture and tourism affected, 300,000 homes destroyed, damaged road $96-$125 billion in damages
2	National response	Declared a national disaster
3	Who responded	TF Katrina (included Active Component US forces), National Guard
4	Elements of success	80-90% residents evacuated before landfall, National Guard provided major assistance
5	Critical elements provided by military	Defined initial requirements, limited communication affected efforts, security to stop violence and looting since 1/3 NOPD officers deserted, the Posse Comitatus Act affected response, transport, medical, search and rescue, self-sustainment
6	Ability of nation to provide relief/enable international military response	Significant

Source: Created by author.

Haiti Earthquake 2010

The third case study focused on the Haitian Earthquake in 2010. On 12 January 2010, Haiti suffered a 7.0 magnitude earthquake (see Appendix B). It killed more than 316,000 people including the head of mission of the MINUSTAH and his deputy, injured 300,000 others, and displaced more than 1 million people (Cecchine et al. 2013, 1). It claimed the lives of numerous government officials and employees, collapsed 100,000 structures, damaged 200,000 more, destroyed the presidential palace and 14 out of 16

government ministries. The earthquake demolished Haiti's medical infrastructure, with total damages estimated at $14 billion. Haiti was declared a national disaster area. The quake was the most destructive natural disaster in the country's history and occurred when Haiti appeared to be making significant strides towards stability.

Particular to the aftermath of this disaster was the vulnerability of the Haitian government and the extent to which it was affected. Several government officials and employees died in the quake, and this left a void in the Haitian Government's already limited ability for governance. In the immediate aftermath of the earthquake, Lieutenant General Keen, (who was in Haiti when the earthquake struck) played a major role in requesting US forces and coordinating with other countries and organizations in Haiti or on their way to Haiti (Cecchine et al. 2013, 4). Response efforts came from US Southern Command who formed Joint Task Force-Haiti; the USAID; and Jamaica Defence Force (JDF) which became the CDEMA response and many other organizations. CDEMA (2010) reported that by 6 February, more than 500 agencies were operating in the impacted area.

Following the quake, the MINUSTAH continued their mission to provide security and stability operations. The US, UN officials and the Government of Haiti agreed that SOUTHCOM should create JTF-H as opposed to a coalition with MINUSTAH. This arrangement allowed a separation of duties; the UN focused on security while the US focused on providing emergency relief. This arrangement reduced the chance of confusion with roles between the US and the UN (Cecchine et al. 2013, xiii). Thus JTF-H carried out Operation Unified Response in concert with MINUSTAH and by 1 February

2010, JTF-H consisted of over 22,000 US service members, 58 aircraft, and 23 ships (Keen et al. 2010, 85). JTF-H stood down on 1 June.

Joint Task Force-Haiti provided tremendous support as well as coordination as one of the first responders in the country. The Special Operations Wing reopened the international airport, while the US Coast Guard and military aircraft delivered relief supplies and evacuated American citizens. JTF-H supported the lead US federal agency, USAID, in providing humanitarian relief. JTF-H was able to provide:

1. Food and water to affected communities;
2. Search and rescue;
3. Reopened the international airport within 28 hours of the earthquake and assumed supervisory control until transferring it to the Haitian Airport Authority in March;
4. JTF-H and Transportation Command established Joint Logistics Over the Shore (JLOTS) capability to bring in equipment and supplies to the seaport;
5. Repaired southern pier in seaport;
6. Critical medical support with the USS Comfort;
7. Security and deterred looting and lawlessness through security;
8. Connected with communities through speaking their language, understanding culture, and living amongst them;
9. Built unity of effort through partnerships with the Government of Haiti, MINUSTAH, USAID, NGOs thus enabling communication and collaboration;
10. JTF-H leveraged social media as well as hundreds of international media to tell the full story;

11. Communication ensured through the use of unsecured commercial networks and programs accessible by all to build a common operating picture;
12. Developed a system for validating and prioritizing global international flights to ensure critical equipment, supplies, and personnel were available.

Central to an effective disaster response is saving lives through quick and efficient response. In Haiti, this became even more pressing due to the devastation of the earthquake and a lack of Haitian government capacity to respond (Keen et al. 2010, 87). According to Keen, the most significant challenge facing the US military and the international community in the initial emergency phase was logistics. These areas presented challenges for the JTF:

1. Inability to determine initial requirements and priorities;
2. Incomplete situational awareness;
3. Lack of integrated logistics command and control structure;
4. Poor reception, staging, and movement of forces, equipment, and supplies into Haiti; and
5. Initial reliance on the only airport into Haiti, Toussaint L'Ouverture International Airport, for the throughput of personnel and relief supplies. (Keen et al. 2010, 87)

In its response effort, the US military quickly responded and restored ports, was able to define initial requirements and thereby tailor requirements particular to the needs. Initially, poor communication hampered the response effort; however, the US military provided leadership which was lacking in the early days after the earthquake. The US also provided airlift, which was critical due to significant road damage. Inherent in the military response was the search and rescue capability, medical support capacity and the ability to self-sustain. A key observation emerging from this case study is that leadership

is one of the key capabilities that militaries bring to crisis action. The US response to the Haiti earthquake brought leadership, transportation (helicopters, transportation ships, and off-road vehicles), technical advantages, experience in urban search and rescue, mobile hospitals and medical staff, personnel, surveillance and reconnaissance technology, radiation monitoring, situation assessment, and damage assessment advantages.

Keen et al. (2010, 89) found that the fundamentals of counterinsurgency doctrine were very applicable to the Haitian disaster relief mission and recommended the following in preparation for providing support to the next major disaster:

1. Develop a robust and capable team to deploy trained and equipped personnel in an early-entry package to conduct assessments and develop requirements, as well as render immediate life-saving assistance.

2. Examine the requirements for an enduring Joint logistics organization, with the appropriate command and control, as part of the Global Response Force.

3. Continue Joint Logistics Over-the-Shore and Joint task force port-opening deployments and exercises, and increase education on these capabilities across all services.

4. Maintain the Global Response Force with a joint responsive capability that can operate in both a permissive and nonpermissive environment with forced entry capability.

5. The host nation provides the necessary leadership for coordinating its efforts. For the host nation government to have legitimacy with its citizens, it must provide early and consistent leadership of all aspects of the humanitarian assistance and disaster relief efforts. (Keen et al. 2010, 96)

An analysis of the Haiti earthquake showed that the massive destruction and human suffering attributed to the earthquake was caused largely by the absence of good governance. Haiti had no disaster resilience built into their system, routinely ignored building codes, and did not institute a national disaster management system. There was unregulated, poor construction of multistory buildings on unstable hillsides. Haiti lacked

the ability to provide basic emergency services to save the lives of her people in times of crisis (Perito 2010, 4).

Table 4 Earthquake Haiti 2010

ITEM NO	ELEMENTS	EARTHQUAKE HAITI 2010
1	Magnitude of storm and effect	Magnitude 7 earthquake, 200,000 dead, 300,000 injured, 1 million homeless, medical infrastructure damaged, damaged roads, most buildings destroyed in capital $14 billion in damages
2	National response	Declared a national disaster
3	Who responded	JTF Haiti, USAID, JDF, CDEMA
4	Elements of success	The US military responded quickly and reopened ports to get relief workers and supplies into country, US military coordinated relief with SOUTHCOM
5	Critical elements provided by military	Defined initial requirements, improved communication capability, military provided leadership, command and control and security, air transport to isolated regions, search and rescue, medical support, JLOTS, and self-sustainment
6	Ability of nation to provide relief/enable international military response	Nil

Source: Created by author.

Hurricane Matthew 2016

Hurricane Matthew made landfall in Haiti on 4 October as a Category 4 storm. This storm was the most intense storm ever recorded at this latitude in the Atlantic Basin;

just 3°N of Trinidad, surpassing Hurricane Ivan in 2004. Official reports from the Government of Haiti and the USAID indicated that heavy rainfall across most of the country resulted in widespread flash flooding, river floods, and mudslides (Stewart 2017, 13). According to Stewart (2017, 12), Hurricane Matthew was liable for 546 deaths in Haiti, an additional 128 persons missing, 439 persons injured and 340,000 people evacuated from their homes. 90 percent of structures along the coast were destroyed and swept out to sea from Tiburon eastward to Saint-Louis-du-Sud in Sud Department. In Les Cayes, 80 percent of crops and animals were destroyed, leaving some families without food according to the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) in Stewart (2017, 13). In Grand'Anse Department, Matthew destroyed hundreds of poorly constructed homes. In Jérémie, Matthew destroyed most of the homes. There was widespread flash flooding, river floods, and mudslides which destroyed roads and bridges, hampering efforts to transverse the country to deliver aid. Some Haitian communities were completely cut off due to flood waters. There was widespread loss of electricity and telephone communication. The storm destroyed houses in both urban and rural areas.

In the aftermath of Hurricane Matthew, unsanitary conditions exacerbated an outbreak of cholera. These conditions arose due to the destruction of infrastructure and contaminated wells; 1,000 Haitians died (Jamieson 2016). The Pan American Health Organization (PAHO) reported that Hurricane Matthew negatively affected more than 2.4 million Haitians (Stewart 2017). The Caribbean Disaster Emergency Management Agency (CDEMA), indicated that at least 120,000 families had their homes destroyed by

Matthew. The World Bank estimated total damages to be about $1.9 billion USD (Stewart 2017, 14).

According to Grünewald and Schenkenberg (2016, 11), the Haitian authorities took the lead in managing and coordinating the response to Hurricane Matthew. The government did not declare a national disaster. Speculations abound about the reason for this, including the proximity of Mattew to national elections. However, few international actors questioned this leadership, which, at first sight, appears to be in line with the Grand Bargain (Grünewald and Schenkenberg 2016, 11), as it emphasizes the role of national and local governments.

Southern Command stood up Joint Task Force-Matthew. JTF-M eventually ramped up to more than 200 Soldiers, Airmen and Marines from Joint Task Force-Bravo (JTF-B), and Special Purpose Marine Air Ground Task Force South (SPMAGTF) personnel. They provided invaluable assistance:

1. Airlift support;
2. Transport of personnel including150 relief personnel to cut off communities in Haiti;
3. Transport of relief supplies including more than 272 metric tons of food;
4. VIP transport;
5. Shelter;
6. Medical supplies;
7. Liaison with local Haitian government officials, the joint task force, and the US Embassy;
8. Critical logistics support.

Southern Command provided a combination of HH-53 Super Stallion, HH-60 Black Hawk, and CH-47 Chinook helicopters to provide heavy and medium lift to support the USAID-led mission to reinforce the Haitian disaster response capabilities (Liapis 2016). At the request of SOUTHCOM, US Transportation Command also provided US Air Force C-17 Globemaster III and C-130 Hercules cargo aircraft to transport critical supplies and personnel in and out of Haiti. The US military response from the US Southern Command eventually grew to more than 20 aircraft, 450 Department of Defense personnel and included two amphibious naval ships carrying 2,600 additional personnel. (Kim et al. 2016).

United States Agency for International Development, as well as numerous NGOs and Inter-Governmental Organizations, also responded. A large number of relief workers were already in Haiti and were thus able to react quickly. Aircraft assisted with aerial reconnaissance of damaged regions to determine assistance required. The roads were so severely damaged that communities had been entirely cut off. When Matthew struck, many Haitians were still in temporary shelters provided in the aftermath of the earthquake in 2010. JTF-M, UNMIH, and relief workers were able to provide search and rescue, medical support and very importantly, the military response was able to self-sustain.

Kim et al. (2016) indicated that the US Coast Guard was one of the first US responders in Haiti after the hurricane. They were fundamental to the configuration and enabling of further US support. They liaised with local Haitian government officials and provided critical logistics support as well as acted as a liaison between the joint task force and the US Embassy.

Table 5 Hurricane Matthew Haiti 2016

ITEM NO	ELEMENTS	HURRICANE MATTHEW HAITI 2016
1	Magnitude of storm and effect	Category 5 cyclone, 1600 dead, 175,000 homeless, Homes and roads destroyed, $1.89 billion in damages
2	National response	Did not declare a national disaster
3	Who responded	JTF Hurricane-Mathew, USAID, other NGOs
4	Elements of success	Relief workers were in country and able to respond quickly
5	Critical elements provided by military	Aircraft assisted initial assessment due to roads were severely affected and restricted relief, Many Haitians were still in temporary shelters Search and rescue Medical support, Self-sustainment
6	Ability of nation to provide relief/enable international military response	Nil

Source: Created by author.

Answers to Research Questions Emerging from Case Studies

Tertiary Questions

Question 1. What Lessons Learned Emerge from Case Studies?

The four case studies were evaluated using six criteria as laid out in table 6. This evaluation showed similarities in the response mechanism of militaries. In all of the case studies, the natural disaster produced casualties, affected the economy, stability, and security of the affected states. The cost of damages was more than US $1Billion, and lines of communication destroyed to varying degrees. In all cases except Matthew, the government declared a national disaster, and a military response was critical to the

success of the response efforts. In all cases, the military was able to define the initial requirements eventually. The military provided critical capabilities such as search and rescue, enabled communication, extended lines of communication through the air and sea lift, provided security where the local police were also negatively affected, provided medical support, and possessed the critical capability to self-sustain. They also provided a significant structure for leadership and command and control.

Hurricane Katrina showed that local responders are quickly overwhelmed by the magnitude of the floods, lawlessness, and loss of life in disasters. During Hurricane Katrina, the local, state, and federal organizations did not have the individual capacities to provide human power, technology, and resources with the strict command and coordination structures that the military is capable of providing. Little can be done to predict or prevent local responders from being negatively affected. However, the cases showed the importance of adherence to and updating of building codes, and the provision of evacuation and shelter facilities for local responders and their families. This requirement is the same for all military responders since they perform best knowing their families are safe.

There were also lessons to be learned from the local response. Katrina highlighted the need for clear command, control, and coordination of the local response. Local resources are usually the first on the scene and have the most knowledge and information on local areas. Local officials, when they can, should retain command and control for the response, with state officials providing coordination and support, and federal officials providing resource and multi-state coordination. Katrina also proved the importance of clear and complete operating procedures in a complex emergency. USNORTHCOM's

incomplete procedures jeopardized interoperability amongst interagency partners in complex emergencies. Clear guidelines including policy and procedures enable mission command in complex emergencies.

Timely identification of needs allows early configuration of relief efforts. The Matthew case is a good example of this. Commander SOUTHCOM anticipated Haiti's needs ahead of Matthew, thus enabling him to pre-position JTF-M closer to the area of impact. Alternatively, with Katrina, communication hampered the timely identification of requirements. Troops were brought in from over 50 different states to provide aid, and they were not a seamlessly integrated entity.

The different types of forces; Title 10, Title 32, utilize different equipment and procedures. These differences caused problems with interoperability. JTF-M was less heterogeneous in nature than the response force for Hurricane Katrina. An integrated framework, joint training, and exercises help responders prepare for disasters while building formal and informal relationships.

Additionally, Katrina reinforced the importance of coordination at all levels amongst all responders. USNORTHCOM's coordination with the Federal Emergency Management Agency (FEMA) was limited. The military has a responsibility to advise on the best employment of forces to ensure maximum employment of resources. This advice is particularly important when employed in supporting roles to civilian entities. There was little clarity on the best employment of military assets according to capability and insufficient coordination between the National Guard and Title 10 Forces. Clear procedures for and the establishment of Joint Reception, Staging, Onward Movement and Integration of forces into theater once established early supports command and control.

Further, insufficient integration of DOD forces with the Federal response during disasters contributed to coordination problems.

General Keen, in the Haiti earthquake case, spoke about the most important resource in a disaster relief effort being logistics. Several factors could have improved the delivery of logistics. The first of these was the inability to determine initial requirements and priorities so that logistics support could be tailored. The second was incomplete situational awareness in the theater of operation. Thirdly, the response did not have an integrated logistics command and control structure which in the civilian supply chain is a major enabler. Fourthly, poor RSOI of forces, equipment, and supplies into Haiti hampered operations. Finally, JTF-H over-relied on the only port in Haiti; Toussaint L'Ouverture International Airport, for the throughput of personnel and relief supplies.

Table 6 Comparison of Evaluated Case Studies against Criteria

ITEM NO	ELEMENTS	Hurricane IVAN Grenada 2004	Hurricane KATRINA USA 2005	EARTHQUAKE HAITI 2010	Hurricane MATHEW Haiti 2016
1	Magnitude of storm and effect	Category 3, 39 dead, 85% of island destroyed, 100% banana and nutmeg crop destroyed, $815 million in damages	Category 3, 1,836 dead, 19% oil production damaged, Agriculture, tourism, 300,000 homes destroyed, Damaged LOCs, $96-$125 billion	Magnitude 7 earthquake 200,000 dead, 300,000 injured, and 1 million homeless, Medical infrastructure damaged, Damaged LOCs $14 billion	Category 5 cyclone, 1600 dead, 175,000 homeless, Homes and roads destroyed, $1.89 billion in damages
2	National response	Declared a national disaster	Declared a national disaster	Declared a national disaster	Did not declare a national disaster
3	Who responded	USAID, CDERA, TTDF	TF Katrina, National Guard,	JTF Haiti, USAID, JDF	Combined TF Hurricane Mathew, USAID
4	Elements of success	Coordinated regional response, International assistance for reconstruction	80-90% residents evacuated prior, National Guard	The US military quickly responded and restored ports, US military took charge of relief effort	Relief workers were in country and able to respond quickly, Aircraft assisted assessment
5	Critical elements provided by military	Defined initial requirements Improved communications for rescue, Security - escaped prisoners Local police responders affected Strategic lift Search and rescue Medical support Self-sustainment	Defined initial requirements Improved communications for rescue, Security - Violence and looting Posse Comitatus Act 1/3 NOPD officers deserted Strategic lift – damages roads Search and rescue Medical support Self-sustainment	Defined initial requirements, Improved communications for rescue, Provided leadership Security – UNMIH Strategic lift – damages roads Search and rescue Medical support Self-sustainment	LOCs were severely affected and restricted relief, Many Haitians were still in temporary shelters Search and rescue Medical support Self-sustainment
6	Ability of nation to provide relief/enable international military response	Limited	Significant	Nil	Nil

Source: Created by author.

In its response effort, the US military quickly responded and reopened ports, was able to define initial requirements and thereby tailor requirements particular to the needs. Initially, poor communication hampered the response effort; however, the US military provided leadership which was lacking in the early days after the earthquake. The US also provided airlift, which was critical due to significant road damage. Inherent in the military response was the search and rescue capability, medical support capacity and the ability to self-sustain. A key observation emerging from this case study is that leadership is one of the key capabilities that militaries bring to crisis action. The US response to the Haiti earthquake brought leadership, transportation (helicopters, transportation ships, and off-road vehicles), technical advantages, experience in urban search and rescue, mobile hospitals and medical staff, personnel, surveillance and reconnaissance technology, radiation monitoring, situation assessment, and damage assessment advantages.

Question 2. What do recent Case Studies say about TTDF's ability to Respond to Disaster Relief Requirements?

Out of the four cases studied for this project, the only one that TTDF responded to was Hurricane Ivan in 2004. The case study showed that TTDF was able to deploy to Grenada in a short period to provide disaster response. It demonstrated that TTDF could provide relief on a small scale with forces that could self-sustain for a short time.

The TTDF's response to Hurricane Ivan in Grenada was well executed. This case is evidence of TTDF's ability to be a credible entity in the provision of regional disaster relief. The equipment and other resources used for regional response are the same as those used for the national response. The duplicity of use of the equipment for both conventional operations and national and regional disaster relief operations limit overall

capability for simultaneous engagement. However, small countries like Caribbean countries, with limited resources, look to the military as a ready and resourced entity with flexibility and personnel to respond to disasters on short notice. Insufficient literature restricts in-depth examination to give a detailed conclusion on Hurricane Ivan.

The procurement procedures specific to emergencies where time is of the evidence is one of the areas that need improvement. There are no after-action or lessons learned reports available on the TTDF's performance in Grenada in the public domain.

Recent case studies indicate that over the years the TTDF has not done a good job of codifying its experiences. It was very difficult to get information on prior operations. A lot of what the author has written on the TTDF derives from policy documents written by various institutions such as ODPM, CDEMA the Institute for Defence Studies and other US sources. There is no manifestation of lessons learned from its 55 years of existence. Trinidad and Tobago has made significant strides towards becoming disaster ready, but this intent needs translation into policy, real action, and capacity development through rigorous research.

The disaster response framework dictated that TTDF must be able to assist the TTFS and TTPS with search and rescue operations, and TTPS with law enforcement, during an emergency above Level 1 (Office of Disaster Preparedness and Management 2010). The TTDF also needs to be able to assist the Ministry of the People and Social Development in providing mass care services such as shelter, food and first aid. Additionally, the TTDF must assist the Ministry of Local Government, Disaster Management Unit and the ODPM with damage and needs assessments after an incident. Finally, the NRF states that TTDF must assist the Ministry of the People and Social

Development with the collection, analysis, and dissemination of information to facilitate the overall provision of services and resources during an emergency or disaster.

Also critical to the response is the provision of facilities for responders' families. The 1st Engineer Battalion SOPs allow for this by providing facilities for their soldiers and their families to secure them and their property.

Question 3. How much Capability is Enough and is an Increase Required?

Sufficient capability for disaster response derives from the enabling capacity of local responders to sustain relief efforts until they are overwhelmed. The Haiti earthquake showed that the affected nation needs a national response system that provides a basic disaster response mechanism to coordinate response and identify needs. Katrina also demonstrated the importance of local command and control and initial response capability. Required capacity for external relief depends on the level of that threshold, and the amount of resilience required in the overall system. This sufficient capacity for military response must bring the capabilities as described in the case studies which significantly aided the success of relief efforts. That is a qualitative answer. The quantification of capability is difficult to ascertain in a qualitative study and will require further study. This further study can provide the information and evidence that can set up the Caribbean nations to develop their capability to withstand better the economic effects of annual disasters which slow development and place them in a never-ending cycle of aid. This research can also provide a framework to configure aid to enable basic self-sustainment.

Military response injects unique capability into a response effort. The military's unique capabilities are requested to augment local capability when it is overwhelmed. An analysis of the cases revealed that these were the most often required capabilities from the military. The list shows the capabilities provided by the military responses to the case disasters:

1. Define initial requirements;
2. Damage assessments of affected areas using reconnaissance aircraft and satellite imagery;
3. Search and rescue and evacuation:
    a. House-to-house search operations;
4. Medical support and treatment for affected civilians:
    a. Critical medical support with the USS Comfort;
5. Provision of meals, water, and ice;
6. Airport and seaport operations:
    a. Repair the international airport and seaport;
    b. Assume supervisory control until transferring it to the Haitian Airport Authority;
    c. Develop a system for validating and prioritizing global international flights to ensure critical equipment, supplies, and personnel were available;
7. Transport:
    a. Materials, supplies, and personnel;
    b. VIP and relief workers;

8. Establish Joint Logistics Over the Shore (JLOTS) capability to bring in equipment and supplies to the seaport;

9. Communication (hours to days):

a. Use of unsecured commercial networks and programs accessible by all to build a common operating picture;

b. Connect with communities through speaking their language, understanding culture, and living amongst them;

c. Build unity of effort through partnerships with the Government of Haiti, MINUSTAH, USAID, NGOs thus enabling communication and collaboration;

d. Leverage social media as well as hundreds of international media to tell the full story;

e. Liaison with local Haitian government officials, the joint task force, and the US Embassy;

10. Civic assistance:

a. Security and the rule of law;

b. Deter looting and lawlessness;

11. Enable international military response;

12. Self-sustainment;

13. Repair to levees and removal of debris;

14. Mosquito spraying operations; and

15. Shelter.

The unique capability that the military provides implies that military capacity is more than local capability. Therefore militaries must develop, train and maintain their

unique capabilities for disaster response, more than local capacity so that they can credibly respond as a last resort.

Question 4. How could Improved Integration Increase Capability?

Improved integration across all sectors of the disaster response framework has many benefits. Specifically as it pertains to integration between TTDF and ODPM, funds are currently not provided to TTDF specifically for disaster relief. Although disaster relief is part of the mandate, due to limited funds, emphasis and priority focuses on building capacity that is directly related to security. As such, the Engineer Battalion fully integrates into the ODPM response framework, utilizing equipment procured by that organization. Capability requirements more than what can be provided by ODPM are contracted out to civilian agencies at a premium price. Additionally, the amount and type of civilian strategic lift contracted for military use in disaster response limits the equipment transported. Full integration across all agencies, including suppliers and those identified to provide a response to emergencies, should be able to draw on resources as required. There should also be some form of standard agreement which makes the procurement process in times of emergencies simpler and quicker while still observing the tenets of responsible procurement. These will include framework contracts where general details are worked out before and only drawn down as necessary.

The Katrina case study reinforced the need for integration across all responders from local to state to federal and across all organizations, Title 10 forces, Title 32 forces, and FEMA so that there is unity of effort. Katrina also demonstrated the importance of a clear command and control structure despite full integration. There must be no doubt

about which organization is in charge and which is supporting. Expectations, reality, and policy, must be synchronized.

Question 5. Does Improved HADR Capability Improve Overall TTDF Capabilities?

Improved disaster response capability will improve the overall capability of TTDF. The US Government Accountability (GAO) in 1993 found that there were inadequacies in the federal strategy for disaster response. They saw that:

> [T]he Department of Defense (DOD) was the only organization capable of providing, transporting, and distributing sufficient quantities of items needed in the most severe catastrophic disasters; and federal response time could be reduced by encouraging agencies to do as much advance preparation as possible before disaster declaration. (GAO 1993)

Similarly, improving the TTDF disaster response capability will enhance its overall capability, on a smaller scale, since disaster response is such a significant part of its national and regional mandate. Notwithstanding, even though improved disaster response capability can improve overall capability, should there be a requirement to do both simultaneously, then there must be considerations for risk reduction.

Secondary Questions

Question 1. What is the Role of the TTDF in Disaster Relief and Humanitarian Assistance?

Trinidad and Tobago National Response Framework (Office of Disaster Preparedness and Management 2010) states the following humanitarian and disaster relief roles for TTDF: “The four formations of the Trinidad and Tobago Defence Force–Regiment, Coast Guard, Air Guard, and Reserves–together contribute land, sea and air capabilities to the Force’s response efforts.” Some roles include damage assessment,

search, and rescue, security (crowd) control, relief supply distribution, hazardous material handling, and collapsed structure search and rescue. The NRF states that the TTDF supports primary responders in disaster responses. The Engineer Battalion becomes the operational arm of the ODPM for national response, and thus they are also primary responders for the ODPM. As the southern SRFP, Trinidad and Tobago and by extension TTDF forms part of the regional response projected by ODPM.

Question 2. What Constitutes Sufficient Preparedness for a Potential Disaster?

Sufficient disaster preparedness considers that the country has firstly measured its vulnerability risk for disasters and examined the likelihood and severity of the occurrence of disasters. Disaster preparedness occurs at various levels but begins at the level of the individual household's understanding, acceptance, and capability of performing their role. Further along, that scale is the national capacity, the regional capability and the ability of the country to facilitate external assistance. Sufficient preparedness occurs when the country can provide initial efforts to save life, limb, and eyesight; where the affected state is overwhelmed, there must be the capacity to enable external assistance. This enabling ability can be in the form of port opening capability so that there is access to the country and to those populations who may be unreachable by land lines of communication. The ability to determine requirements to a reasonable degree based on the extent of the damage is also a critical capability for the affected country. This capability allows the tailoring of response efforts as early as possible.

Additionally, clear command and control infrastructure is essential for a coordinated local response. Command of response effort should reside first with local

officials, then with state officials playing a coordinating and supporting role and federal, national or regional response playing a resource and multistate coordinating role. Applicable laws must be clear on the use of military forces: who can request them and the necessary process for this since time is always of the essence. This process must be rehearsed and understood by the necessary personnel. Rehearsed responders can establish formal and informal relationships with all personnel involved, including the affected communities. To effectively establish the role of the military in disaster response operations, the limits and restrictions of the military's role need to be explored to eradicate uncertainties, misinterpretation of media, and incorrect public criticism.

Based on the answer derived from question 3 of the tertiary questions, the top twelve capabilities identified have proved critical to the success of military disaster relief operations. The author, therefore, suggests that these are the unique military capabilities that will constitute sufficient military preparedness:

1. Define initial requirements;
2. Damage assessments of affected areas using reconnaissance aircraft;
3. Search and rescue and evacuation;
    a. House-to-house search operations;
4. Medical support and treatment for affected civilians;
5. Provision of meals, water, and ice;
6. Airport and seaport operations
    a. Repair the international airport and seaport;
    b. Assume supervisory control until transferring it to National Airport Authority;

c. Develop a system for validating and prioritizing global international flights to ensure critical equipment, supplies, and personnel were available.

7. Transport:

a. Materials, supplies, and personnel;

b. VIP and relief workers;

8. Establish Joint Logistics Over the Shore (JLOTS) capability to bring in equipment and supplies to the seaport;

9. Communication (hours to days):

a. Use of unsecured commercial networks and programs accessible by all to build a common operating picture;

b. Connect with communities through speaking their language, understanding culture, and living amongst them;

c. Build unity of effort through partnerships with Government, UN, USAID, NGOs thus enabling communication and collaboration;

d. Leverage social media as well as hundreds of international media to tell the full story;

e. Liaise with local officials, the joint task force, and the US Embassy;

10. Civic assistance:

a. Security and the rule of law;

b. Deter looting and lawlessness;

11. Enable international military response; and

12. Self-sustainment.

Question 3. How well can TTDF Respond to Disaster Relief Requirements?

The TTDF's role in disaster response is clearly laid out in the national disaster response framework (Appendix C). It also states at what stage of the disaster each unit is expected to respond. It is unclear just how well these roles are extrapolated but the ODPM regularly hosts exercises that coordinate with all national disaster responders. These joint exercises build formal and informal working relationships amongst the national agencies charged with disaster response. They also incorporate rehearsal of disaster response mechanisms and acts as an enabler for the further refinement of policies and procedures.

Militaries must train their personnel in principles and practices of humanitarian affairs and response. Militaries contribute to the common good, provide urgency and can rapidly respond. They prove that there is no capable civilian alternative, and embody the organizational culture of service to others. The response to Hurricane Ivan showed that the TTDF could provide limited aerial, naval and land search and rescue; route clearance; limited transportation; security; limited communication capability; and command and control. They were among the first in Grenada and proved to be an asset in the management of the seaport to enable entry of aid into the country. The TTDF possesses the ability to manage both the air and sea ports though not the capability to repair them. Repair of these ports would fall to another government institution such as the Ministry of Works and Transport (MOWT).

Also critical to the Grenada response was the ability for the military to coordinate relief distribution. There is a warehouse arrangement by ODPM where hurricane relief supplies and equipment are preconfigured and prepositioned. The TTDF as the

operational arm of the ODPM integrates into this construct and utilizes engineer and other equipment procured specifically for this purpose. However, there is no established national framework to obtain additional emergency supplies that may be required such as fuel, water, and fresh food outside of the normal public procurement process. This process is often inordinately slow and requires the injection of a directive from the strategic level such as the Chief of Defence Staff or the Minister of National Security to deviate from the established process significantly.

This research uncovered gaps in TTDF's disaster response and planning capacity. TTDF is constrained in its planning and response capability as follows:

1. Lack of defense research (planning);
2. Poor codification and examination of TTDF military experiences (planning);
3. No budget for disaster response (planning);
4. Limited logistics capacity for simultaneous operations (response);
5. No procurement framework for disaster relief supplies (response);
6. Limited TTDF policies and procedures for disaster response (response); and
7. Limited disaster response equipment (response).

Question 4. How well does TTDF Integrate with ODPM and CDEMA?

The TTDF deployed to Grenada as the Sub-Regional Focal Point (SRFP) for the southern Caribbean under the construct of the CDEMA Regional Response Mechanism (RRM) for disaster response.

The National Emergency Operation Center (NEOC) "provides centralized coordination, control and decision making of emergency response and relief operations

on a 24 hour basis if necessary within Trinidad and Tobago." The NEOC serves as the strategic command center for command and control systems in the event of all emergencies (ODPM website). This allows the NEOC—EOC system to be effectively and efficiently aligned to the operational command centers (OCCs) of all lead response agencies (TTPS, TTDF, TTFS and GMRTT). The NEOC now provides the space that allows the executive arm of GORTT to be informed in a strategic manner, on a timely basis on the status of all emergencies and threats.

The TTDF, as well as other first responders, provide permanent liaison officers to the NEOC to assist with the integration of efforts. Critical to the effort is the provision of preplanned facilities for first responders and their families. Predetermined evacuation routes and shelter sites for first responders and their families is critical. The TTDF has established formal and informal relationships with the ODPM. They conduct regular joint training which culminates in an annual training exercise with all agencies and responders in the disaster response framework. The communication infrastructure across major units such as the TTDF, TTPS, and ODPM are similar, so it enables interoperability. There must be simplicity in procedures.

The Engineer Battalion is placed on standby to respond to every disaster in Trinidad as the operational arm of the ODPM. They can be augmented by other TTDF units if required such as the TTAG or TTCG or infantry troops. This standby leads to deployment once the local response is overwhelmed. Disaster response capabilities include search and rescue, removal of debris, retrieval of dead bodies, aerial surveillance, needs assessment, and VIP transport.

The military's capacity for speed and effectiveness, adaptive procedures including on-scene and empowered command and control, the ability to coordinate the response to a dynamic and evolving situation, among vastly different other militaries, civilian and government entities in addition to international NGOs. They can also create a permissive environment along with strategic public affairs, diplomacy, and communication. Militaries also have an advantage of the establishment of a relationship with the host nation military. There is also the potential for military effectiveness at all levels. Situational awareness, a unified and integrated logistics command and control and functioning ports (sea and air). A low capability trap exists where a low capability and a high work pressure gets embedded in the organizational culture. The organization becomes dependent on firefighting and working harder to solve problems caused by inefficiencies and low capability instead of instituting proper systems.

Summary and Conclusions

Robinson (2004, 57) in his analysis found that both the World Bank and Harriott agree that there is a historical and contemporary disinclination to fund the Caribbean military forces adequately. As a result of these financial challenges, the Caribbean's defense establishments suffer from significant monetary shortfalls to the military. These include insufficient air and sea transport to deploy Caribbean forces with their equipment; inadequate logistic capability; inadequate deployable command and control; and deficiencies in secure, interoperable communications. Caribbean nations have improved significantly in disaster response planning over the years. However, sufficient military funding needs to be allocated to translate these plans into action. Granted Caribbean

militaries are self-defence forces; it must be highlighted that disasters are considered a threat to internal and regional security due to the devastating impacts economically.

Inherent in the military response to a disaster is its capacity for speed and effectiveness, adaptive procedures including on-scene, and empowered command and control. The ability to coordinate the response to a dynamic and evolving situation amongst the vastly different military, civilian, and government and nongovernmental entities is also crucial. Additionally, creating a permissive environment, the prominence of strategic public affairs—public diplomacy and the way key recurring themes appear to point to the TTDF being able to sustain itself and act as an enabler for international assistance. These areas include initial port opening capability, needs assessments capability, initial medical to save life, limb, and eyesight, search and rescue, C4I capability, strategic lift capability, security, and self-sustainment. The configuration and deployment of this aid for future operations is one of the areas for further examination.

Finally, natural disasters disrupt the existing supply chain for goods and services. Since military forces are prepared to operate in austere or disrupted environments, their supply chains are less affected by disasters. The military's self-sustainment ability enables the capacity to direct efforts at repairing or restoring the critical elements of the pre-disaster supply chain. In the meantime, they also bring some limited capability to temporarily replace some of the pre-disaster supply chains, while repair and restoration efforts are underway. Seeing the situation in this light may help focus efforts on the disaster relief itself, and highlighting those areas where military forces can invest in their capabilities most wisely.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Introduction

The purpose of this study is to investigate the TTDF's role and readiness in disaster response. This study seeks to answer the primary question: "What gaps exist in the ability of the TTDF to provide logistics support in response to Humanitarian Assistance and Disaster Relief operations?"

Chapter 5 consists of three major parts. Firstly, the author summarized the findings from chapter 4. Next, an interpretation of the findings is presented to answer the primary research question. Lastly, the author presents recommendations for improvement, implementation, and further study.

The TTDF's role in disaster response is currently mandated in the NRF as one of the first responders both nationally and regionally as the SRFP. When the ODPM is activated the Engineer Battalion becomes its operational arm. Therefore, at least one unit of the TTDF is always a main disaster relief responder. The Engineer Battalion has responded to almost every national natural disaster for the past 10 years including local floods, landslides, and hurricanes. There is an increasing expectation by the population, and the government, that TTDF is always ready to respond, in this case, to disasters. As such, the safety and sense of comfort that the community derives from a military response are very evident. Trinidad and Tobago's location just south of the hurricane belt makes its capacity for response even more important regionally as the southern SRFP.

Brief Summary of Findings from Chapter 4

This thesis uncovered gaps in TTDF readiness for and response to disasters. The gaps that exist in the ability of the TTDF to provide logistics support in response to Humanitarian Assistance and Disaster Relief operations planning and response capability as follows:

1. Lack of defense research (planning);
2. Poor codification and examination of TTDF military experiences (planning);
3. No budget for disaster response (planning);
4. Limited logistics capacity for simultaneous operations (response);
5. No procurement framework for disaster relief supplies (response);
6. Limited TTDF policies and procedures for disaster response (response); and
7. Limited disaster response equipment (response).

Sufficient preparedness occurs where the country can provide initial efforts to save life, limb, and eyesight. If the affected state's capacity is overwhelmed, there must be the framework to enable external assistance. An assessment of disaster risk will also determine the extent of preparedness that is required. The ability to identify requirements to a reasonable degree based on the magnitude of the damage is a critical capability for the affected country; thus tailoring the response efforts as early as possible. This enabling ability can be in the form of port opening capability so that there is access to the affected areas of the country and to those populations who may be unreachable by land. The ability to determine requirements to a reasonable degree based on the extent of the damage is also a critical capability for the affected country. This ability to determine requirements, too, allows the tailoring of response efforts as early as possible.

Additionally, explicit command and control infrastructure is essential for a coordinated local response. Command of response effort should reside first with local officials, then with state officials playing a coordinating and supporting role and federal, national or regional response playing a resource and multistate coordinating role. Applicable laws must be clear on the use of military forces: who can request them and the necessary process for this since time is always of the essence.

The TTDF, as well as other first responders, provide permanent liaison officers to the NEOC to assist with the integration of efforts. Essential to the effort is the provision of preplanned facilities, predetermined evacuation routes and shelter sites for first responders and their families. The TTDF has established formal and informal relationships with the ODPM through the regular conduct of training and exercises. The communication infrastructure across major units such as the TTDF, Trinidad and Tobago Police Service (TTPS), and Office of Disaster Preparedness and Management (ODPM) are similar, so it enables interoperability.

Based on the answers derived from chapter 4, the author suggests that the unique military capabilities that will constitute sufficient military preparedness for the TTDF are as follows:

1. Ability to self-sustain and enable international assistance;
2. Initial medical to save life, limb, and eyesight;
3. Search and rescue;
4. Needs assessments capability;
5. Initial Port opening capability;
6. Command, control, communications, computer, and intelligence capability;

7. Security; and

8. Airlift capability.

Interpretation of Findings Described in Chapter 4

The results solidify the role of the TTDF as one of the first responders in disaster relief as the operational arm of the Office of Disaster and Preparedness Management (ODPM). It reiterates the importance as a small island nation of having a military that is disaster responsive. Further, Trinidad and Tobago's location south of the hurricane belt and their appointed role as an SRFP means that the nation, as well as the islands for which we are responsible, have an expectation that we can perform by our stipulated mandates.

The National Response Framework dictated that TTDF needs to be able to:

1. Assist the Trinidad and Tobago Fire Service (TTFS) and the Trinidad and Tobago Police Service (TTPS) with search and rescue operations.
2. Assist the TTPS with law enforcement, during an emergency above Level 1.
3. Assist the Ministry of the People and Social Development in providing mass care services such as shelter, food and first aid.
4. Help the Ministry of Local Government Disaster Management Unit and the Office of Disaster Preparedness Management (ODPM) with damage and needs assessments after an incident.
5. Support the Ministry of the People and Social Development with the collection, analysis, and dissemination of information to facilitate the overall provision of services and resources during an emergency or disaster.

The NRF gives a significant amount of responsibility to the TTDF apart from the roles and responsibilities assigned to the Engineer Battalion in support of ODPM. These roles suggest that the government has placed significant importance on the role of the TTDF in disaster response. Therefore, it is important that efforts be made to close the gaps that exist in the TTDF disaster response capability.

Research on the TTDF proved to be extremely difficult. This study could have been improved by the use of questionnaires to get the primary data. Questionnaires and interviews would have been included in the author's research methodology if there were sufficient resources. However, a busy schedule, heavy workload and limited access to subjects excluded the use of that methodology. Published data on the TTDF is almost non-existent, and unless this changes, the TTDF will lose knowledge and experience through lack of codification. There has to be immediate and rigorous defense research and codification of the achievements and lessons learned by the TTDF over the last 55 years.

Recommendations

For Improvement

The author recommends further refinement of TTDF capabilities through refinement of the National Response Framework (Appendix C). The role of the military needs to be clearly defined since this option is often the most expensive option. Once the military becomes heavily involved in disaster relief, its other functions may suffer, particularly in the case of the TTDF as a small entity with limited funds. Table 7 is an attempt at codifying the TTDF's role in national response and its role as an enabler to international response as the severity of the disaster increases.

The NRF indicates the responders at each stage of the disaster response framework. The framework refers to levels, but the diagram shows no levels. The author has superimposed the levels as laid down in the write up for the NRF onto the framework diagram. Secondly, a threshold was included to show the point at which the local responders become overwhelmed and request the deployment of the TTDF. Although the NRF states that there is a threshold, the diagram does not show this threshold.

This threshold signifies the deployment of the TTDF, however, once the ODPM activates, the Engineer Battalion becomes its operational arm. Therefore, this means the TTDF inserts much earlier in the disaster response than the threshold level. The units of the TTAG and TTCG are also usually providing initial transport for viewing the extent of damage to the affected areas. TTDF assistance continues throughout the Levels 2 and 3 with a corresponding increase in the severity of the effects on the population. The model then reaches to the point where the local capacity is overwhelmed, and a national disaster is declared together with requests for assistance. Here, the TTDF also has a role to play in ensuring that capacity is maintained to enable aid to come into the country and to reach affected communities. Ensuring that the sea and airports are functioning and that relief can reach the most vulnerable populations.

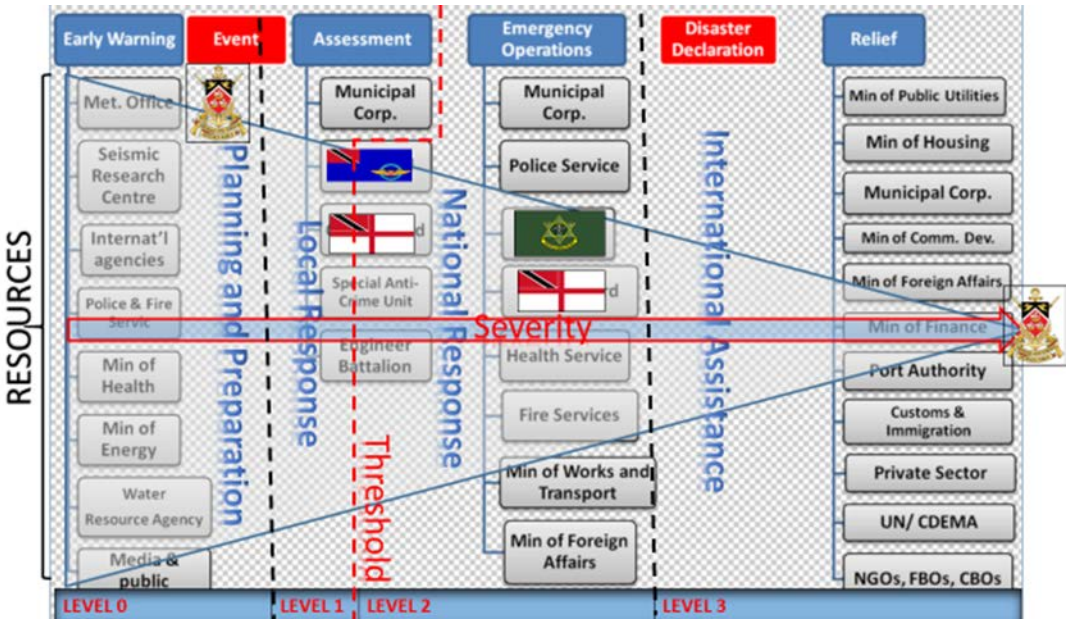


Figure 3. Modified T&T NRF

Source: Created by author.

For Further Study

The author was unable to answer question 3 of the tertiary questions fully. The quantification of capability is difficult to ascertain at this time and therefore requires further study. The author recommends the undermentioned for further study:

1. TTDF integration with CDEMA and the regional military disaster response.
2. The Joint Logistics Over The Shore (JLOTS) as a regional capability as it may prove to be an expensive capability.
3. Quantification of TTDF required disaster relief capacity.

The TTDF can perform the roles mentioned above provided that the requirement is minimal. Simultaneous provision of logistics support and self-sustainment operations is difficult for more than a few days. The above list of capabilities is considered for further

dissection to determine where capability is lacking and where it is suited for development. TTDF has no JLOTS capability and the author recommends that it be considered as a regional development capability.

For Implementation

Final recommendations suggest that there is room for improvement in the TTDF development of policy and its translation into actual capability. There appear to be lots of theory at the national level, but the lack of policy has stymied potential development. The author, therefore, recommends the following:

1. More TTDF involvement in disaster response planning;
2. Empower junior officers to become involved in contributing to the body of knowledge of Caribbean defense research;
3. Develop a mechanism to codify lessons learned and their application to improvements in national security. Commander Southcom made an excellent point when he spoke about the relationship between disaster response and small island states' national security. Research is required in all spheres of defense if there is to be sustainable growth;
4. Develop an Institute for National Defence Research with the possible expansion toward Caribbean Defense Research to develop the body of knowledge on local and regional defense and security. The national institute could associate with a local tertiary education institute such as the University of Trinidad and Tobago (UTT). A reservoir of knowledge and research already exists from US schools that senior officers TTDF and other Caribbean military

students attend. The author, therefore, posits that this research could contribute to the defense research institute;

5. Develop a formal mechanism for disaster relief expenditure to include some form of standard agreement. A standardized process can improve the procurement process in times of emergencies, making it simpler and quicker while still observing the tenets of responsible procurement. These can include framework contracts where general details are worked out before and only drawn down as necessary;
6. There should be regional military integration with a common platform of equipment, strategy, policies, and procedures that enable seamless integration when needed. Regional exercises like Fuerzas Aliadas Humanitarias (FAHUM) and Tradewinds encourage cooperation and sharing of knowledge, experience, and building relationships. However, there is no regional military integration at the policy level; and
7. Empower other stakeholders such as universities and public and private institutions to contribute to this body of knowledge.

Summary and Conclusions

Small Island Developing States (SIDS) of the Caribbean are particularly vulnerable to a range of disasters, both natural and man-made (UNDP 2011, 23). TTDF is one of the responders nationally, but shortfalls persist such as transportation, storage facilities, the maintenance of individual power, fuel, and emergency supplies in TTDF disaster response capability. These factors limit the ability to get resources to the required locations. Once deployed, there are also issues such as continuity of supply, feeding,

sanitation spares, fuel, and other resources needed to support the troops that are engaged in the response effort.

There must be at least two key performance criteria to assess the performance of an organization. According to Beamon and Balcik (2008), “the increased frequency and scale of disasters, scarce resources, funding competition, and the need for accountability require more efficient, effective and transparent relief operations that must be effectively measured.” There is little chance for the TTDF to provide credible disaster relief unless there is an agreement for actions to improve quality, value, effectiveness and efficiency. Integrated logistics tends to promote more reliable order cycles and predictive supply to end users and customers.

According to Stuart and Johnson (2011, 66), the US Air Force has personnel assigned to dedicated disaster response teams. These teams are prepared for rapid deployment and train together, prepared for these potential disasters. Similarly, national disaster responders and regional military and civilian responders must train together and develop policies for improved interoperability.

During Hurricane Katrina, the local, state, and federal organizations did not have the individual capacities to provide human power, technology, and resources with the strict command and coordination structures that the military is capable of providing (Anderson 1970; Brake 2001; US House of Representatives 2006 cited in Kapucu 2011, 20). The US military was able to provide the capacity in excess of local capabilities. Similarly, if the TTDF is to remain a credible disaster relief response entity, it must possess capacity unique from and in excess of local responders.

In Haiti, the US military quickly responded and restored ports, was able to define initial requirements and thereby tailor requirements particular to the needs. Initially, poor communication hampered the response effort; however, the US military provided leadership which was lacking in the early days after the earthquake. The US also provided airlift, which was critical due to significant road damage. Inherent in the military response was the search and rescue capability, medical support capacity and the ability to self-sustain.

A key observation emerging from all the case studies is that leadership is one of the key capabilities that militaries bring to crisis action. The US response to the Haiti earthquake brought leadership, transportation (helicopters, transportation ships, and off-road vehicles), technical advantages, experience in urban search and rescue, mobile hospitals and medical staff, personnel, surveillance and reconnaissance technology, radiation monitoring, situation assessment, and damage assessment advantages.

Operational limitations that exist for TTDF includes the heavy reliance on commercial transport to move people, supplies, and equipment in and out of the theater. This heavy reliance is necessary since TTDF does not have the integral capacity to move. Overreliance on civilian transport can and has negatively affected capability, effectively restricting movement times and equipment type to the availability of civilian carriers. This form of transportation is very costly to the TTDF since there is no separate budget for TTDF disaster relief, funds come from annual appropriations. The supply chain is less organized for humanitarian relief and often require imaginative solutions to relieve suffering in emergencies. In this case, resupply develops through coordination with civilian suppliers, commercial aircraft, and TTAG and TTCG assets where possible. The

use of these assets for relief operations and self-sustainment operations lessens overall capability. The Ivan case study suggests that there should be a strategy to ensure supply and resupply during emergencies.

Overall, there is the potential to reduce the loss of lives due to inefficiencies in the current response mechanism to national disasters. The increasing frequency and impact of disasters, together with the vulnerability and devastating effects in the Caribbean, requires that urgency and importance be attached to improve response efforts through resourcing. The principal responsibility for disaster response rests with civilian agencies at local, state and federal levels; however, only the military has the workforce, equipment, training and organization to respond to catastrophes.

Natural disasters disrupt the existing supply chain for goods and services. Since military forces are prepared to operate in austere or disrupted environments, their supply chains are less affected by disasters. The military's self-sustainment ability enables the capacity to direct efforts at repairing or restoring the critical elements of the pre-disaster supply chain. In the meantime, they also bring some limited capability to temporarily replace some of the pre-disaster supply chains, while repair and restoration efforts are underway. Seeing the situation in this light may help focus efforts on the disaster relief itself, and highlighting those areas where military forces can invest in their capabilities most wisely.

Finally, any improvements in TTDF doctrine, organization, training, material, and facilities will have a corresponding and significant effect on overall capability. This study has the potential to save lives since improved military disaster response mechanisms can

enhance efficiency in disaster response. This work will also add to the body of knowledge for TTDF and Caribbean defense research.

APPENDIX A

SAFFIR-SIMPSON HURRICANE WIND SCALE

(NATIONAL HURRICANE CENTER)

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3	111-129 mph 96-112 kt 178-208 km/h	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4	130-156 mph 113-136 kt 209-251 km/h	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	157 mph or higher 137 kt or higher 252 km/h or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: National Hurricane Center, “Saffir-Simpson Hurricane Wind Scale,” accessed 10 May 2017, http://www.nhc.noaa.gov/aboutsshws.php.

APPENDIX B

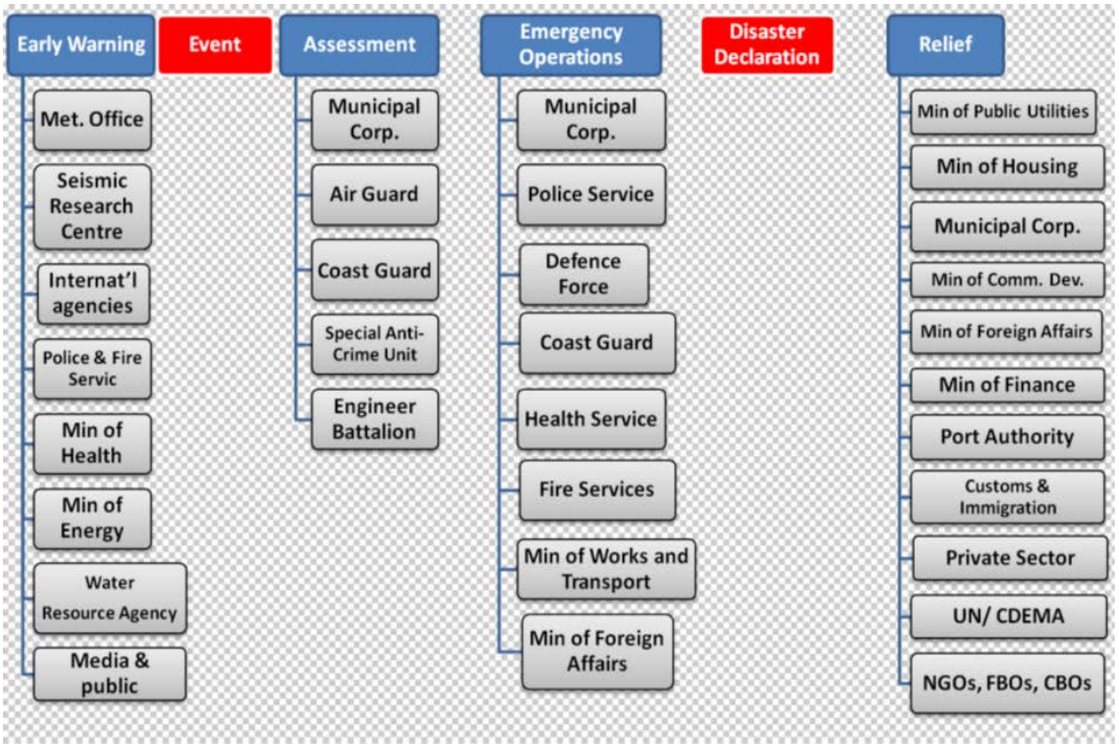
THE RICHTER SCALE (OKLAHOMA ECONOMIST 2016)

Richter Scale	Shaking	Example	Description/Damage
1.0-3.0	Not felt		Not felt except for a few
3.0-3.9	Weak Weak		Felt by a few especially by persons on top floors Felt noticeably by persons indoors
4.0-4.9	Light Moderate		Felt by many, outdoors by few. Dishes, windows disturbed Felt by nearly everyone. Broken glass, objects overturned
5.0-5.9	Strong Very strong		Felt by all. Heavy furniture moved, fallen plaster. Damage negligible in buildings of good design, considerable with poor design
6.0-6.9	Severe Violent	Italy 2009 (6.3)	Damage great in poorly constructed buildings. Fall of chimneys, monuments Buildings partially collapse and shift off of foundations.
7.0-7.9	Extreme	Haiti 2010 (7.0) China 2008 (7.9)	Wooden buildings destroyed. Few if any structures remain standing. Bridges destroyed. Rails bent. Total destruction
8.0 and greater	Extreme	Sumatra 2004 (9.1)	Destruction across several 100 km

Source: Oklahoma Economist, "The Richter Scale," accessed 10 May 2017, https://www.kansascityfed.org/publications/research/oke/articles/2016/economic-damage-large-earthquakes.

APPENDIX C

NATIONAL RESPONSE FRAMEWORK (NRF 2010)



Level	Response Activity
1	A localised incident. Such incidents fall within the jurisdiction and capacity of the local government authorities and other first responder agencies within a municipality or the Tobago Emergency Management Agency, in the case of Tobago. The first responder agencies may include the Trinidad and Tobago Police Service (TTPS), the Trinidad and Tobago Fire Service (TTFS), and the health services, as necessary. At Level 1, the Emergency Operations Centre of the Municipal Corporation or Tobago will be activated, as needed, to coordinate the regional, borough, or city response.
2	The emergency or disaster event usually affects two or more municipal regions/Tobago, or while confined to one municipality, may be of a very serious nature but can still be dealt with by using the resources available at the municipal and/or national level. NEOC partially activated
3	Should the national resources be overwhelmed, the resident will declare a national emergency with foreign assistance being requested, if necessary.

Source: Office of Disaster Preparedness and Management, "National Response Framework," 2010, accessed 5 October 2016, http://www.odpm.gov.tt/node/59.

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