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WORLD MARITIME UNIVERSITY

Dalian, China

**Analysis of current situation and
countermeasures of maritime search
and rescue in the waters of Pearl River**

Estuary

By

W1701464

The People's Republic of China

A research paper submitted to the World Maritime University in partial
Fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE

(MARITIME SAFETY AND ENVIRONMENTAL MANAGEMENT)

2018

DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of research paper: **Analysis of current situation and countermeasures of maritime search and rescue in the waters of Pearl River Estuary**

Degree: **MSc**

With the strong support of the China Government in the development of the Guangdong-Hongkong-Macao Greater Bay Area and the construction of sea-crossing bridges, in the waters of Pearl River Estuary, maritime activities have increased significantly, and maritime accidents have occurred frequently. Coupled with frequent extreme weather in the waters, maritime search and rescue work is particularly arduous. In this paper, the author analyzed the current situation of search and rescue work in the waters of Pearl River Estuary, proved the necessity of establishing a scientific, modern and three-dimensional SAR system that meets the needs of the new situation and taking appropriate scientific measurements to plan and effectively manage it. The author also strove to provide countermeasures to establish such system in order to promote the capability of maritime search and rescue by absorbing foreign advanced search and rescue practices and experiences.

KEY WORDS: SAR, Pearl River Estuary, the Greater Bay Area, MRCC

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LIST OF ABBREVIATIONS

IMO	International Maritime Organization
SAR	Search And Rescue
MRCC	Maritime Rescue Co-operation Centers
PRE	Pearl River Estuary
MSA	Maritime Safety Administration
TEU	Twenty-foot Equivalent Unit
USA	United States of America
UK	The United Kingdom
GFS	Government Flying Service
CFA	Chinese fishery administration
NRB	Nanhai Rescue Bureau of the Ministry of Transport of PRC
BDF	Border Defence Force of The Chinese Armed Police Force
CCG	China Coast Guard
CMS	China Marine Surveillance
GSB	Guangzhou Salvage Bureau of the Ministry of Transportation
GT	Gross Tonnage
DWT	Dead Weight Ton
UCG	US Coast Guard
MCA	Maritime and Coastguard Agency

HM	Her Majesty's
HMCG	HM Coastguards
JCG	Japan Coast Guard
MLIT	Ministry Of Land Infrastructure And Transport

CHAPTER 1

INTRODUCTION

1.1 Research Background

China is a permanent member of the United Nations and an A-level council member state of the International Maritime Organization (IMO). In 1985, China approved the accession to the National Convention on Maritime Search and Rescue 1979 (Xu, 2009, pp. 35-38). As a Contracting State of the Convention, China undertakes the responsibility of maritime search and rescue (SAR) and the international humanitarian obligations for timely rescue of maritime distress and human life.

In 1974, according to the requirements of the State Council and the Central Military Commission, China established the maritime security headquarters and renamed it as Maritime Rescue Co-operation Centers (MRCC). In order to further strengthen the organization and leadership of the National Maritime SAR work, coordinate and integrate the various maritime SAR sectors, in 2005, The Chinese Government set up an inter ministerial joint meeting of national maritime SAR. At present, China has initially formed a maritime SAR system which combines maritime SAR emergency command and professional social emergency rescue resources (Kong, & Ruan, 2004, pp. 22-24).

The maritime SAR work is promotes the coastal economy development, the sea enterprise prosperous safety control. But at present, there are some deficiencies in

maritime SAR system of China. In recent years, China has improved the maritime SAR capability greatly by increasing the investment in the construction of maritime SAR equipment, but there is still a gap compared with the developed countries. At present, China's specialized rescue ships are relatively old, and the comprehensive maritime SAR capabilities of these ships are not excellent (Wang, 2010, pp. 59-61). In the case of long distance and large waves, the SAR capability of Chinese specialized SAR ships is not strong enough. The quantity and quality of maritime SAR infrastructure and equipment, the rescue capability of maritime accidents, especially the ability to maintain national maritime rights and interests, and the fast and effective SAR capability under the strong storm are still far from the developed countries.

Pearl River Estuary (PRE) is located in the center of the Guangdong-Hong Kong-Macao Greater Bay Area (the Greater Bay Area), covering the Pearl River Delta city group such as Guangzhou, Shenzhen, Zhuhai, Hongkong and Macao. It is the water transport hub in Southern China and the busiest channel in china. More than 4000 ships voyage through the waters of PRE every day, and annual traffic can reach 1.5 million ships. Coupled with the extreme weather, the risk of ship navigation in the waters is enormous. According to statistics, in the last three years, there are about 400 dangerous case in the waters of PRE (including 23 serious accidents), accounting for 6.60% of the national maritime dangerous case, and more than 4900 people in distress, accounting for 9.42% of the national maritime distress personnel (Zhou, 2016, pp. 6-11). The annual average accident number accounts for more than 40% of the total number of maritime accidents occurred in Guangdong. Maritime transportation has high risk. Although the waters of PRE has the outstanding advantage of developing shipping, it also has an objective disadvantage from the angle of water traffic safety. With the implementation of major national

strategies such as "The Belt and Road Initiative", "The Guangdong-Hong Kong-Macao Greater Bay Area", and the construction of cross-sea bridges including Hongkong-Zhuhai-Macao Bridge and Shenzhen-Zhongshan Bridge, the shipping activities in the waters of PRE has increased greatly, and the emergency SAR task has become increasingly arduous.

1.2 Objectives of research

In recent years, the frequent occurrence of ship accidents in the waters of PRE has caused serious losses of life and property, which has attracted the attention of international society. The above mentioned background implies the necessity of establishing a scientific and modern maritime SAR system in the waters of PRE. The author, as a staff of Guangzhou Maritime Safety Administration (MSA), who's most working hours are spent in the waters of PRE, and participated in on-scene SAR operation many times, has a strong desire to explore a way to improve the maritime SAR capability with the regulated management mode and innovative thoughts in this waters. Thus, this paper would analyze, in terms of current situation, the possibility and ways of establishing a rapid, effective, unified and coordinated maritime SAR system in the waters of PRE.

The objectives are:

- a) draw attention to the issues discussed in the paper;
- b) sum up advanced foreign practice and experience related to maritime SAR;
- c) offer a fundamental solution for improving the maritime SAR capability in the waters of Pearl River Estuary;
- d) facilitate the development of maritime SAR system in the waters of Pearl River Estuary; and
- e) provide information supports for decision-maker(s).

1.3 Methodology

In order to fully meet the objectives, this paper essentially concentrates on the following contents based on literature study, investigation method, case study method, and comparative method as well:

- a) introduction and corresponding analyses of current situation and of maritime SAR in the waters of Pearl River Estuary;
- b) defects in the current maritime SAR system in the waters of Pearl River Estuary;
- c) foreign successful practice of maritime SAR system; and
- d) proposed solution for establishing a modern and scientific maritime SAR system in the waters of PRE.

1.4 Structure of the Paper

The research paper is mainly comprised of seven chapters: **Chapter one** provides background information, research objectives and methodologies to be used in subsequent parts; **Chapter two** broadly introduce the current shipping situation in the waters of PRE and the challenges and opportunities posed by the proposal of development strategy of the Greater Bay Area; **Chapter three** mainly focuses on analyzing the ship accidents occurred in the waters of PRE, including the jurisdiction and causes of these accidents, a quantitative method will be conducted to further strengthen the objective conclusions; **Chapter four** mainly focuses on analyzing the current maritime SAR system in the waters of PRE, including organization structure, SAR forces and the defects of this system; **Chapter five** briefly introduce several advanced foreign maritime SAR systems including United States of America (USA), The United Kingdom (UK) and Japan and summarize their advantages; **Chapter six** primarily puts forward the corresponding countermeasure proposals for establishing

a modern and scientific maritime SAR system in the waters of PRE, including establishment of the PRE MRCC, the professional maritime SAR volunteer team, and the training system, etc; **Chapter seven** makes final summary and conclusion, and highlights of this research paper.

CHAPTER 2

Shipping situation in the waters of PRE

2.1 The waters with busy marine traffic

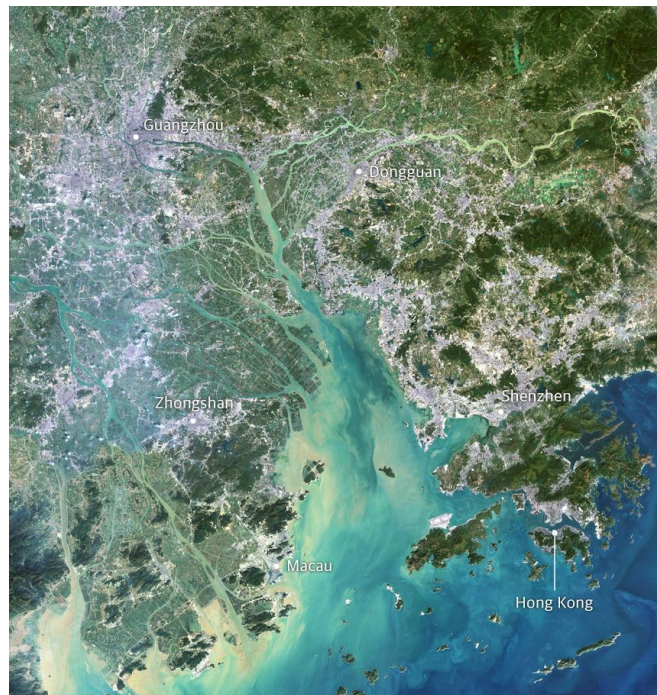


Figure 1 - Satellite aerial map of PRE (Source: Google map)

The PRE is surrounded by islands, and there are many deep-water ports in this waters and many anchorages in the harbor. It is the golden waters for port production and ship navigation, and one of the busiest and most dense waters in China because of its complex marine routes and arduous water transportation (He, & Cai, 2007, pp. 19-20). It borders the South China Sea and is navigable with the world's major ports,

domestic coastal ports and major rivers, and connects the West River, the North River, the East River and the Pearl River Delta water network of Guangdong Province. There are more than 4000 vessels sailing in this waters every day, including several tons of small fishing boats to 300 thousand tons of oil tankers. This waters is the prone area of ship accidents due to its special geographic location, obviously climate change and crowded ships. According to statistics, over the years, the ship accidents occurred in this area account for more than 1/3 of the total accidents occurred in Guangdong Province (Lin, 2017).

2.2 The waters with a world-class port group

As one of the three most developed regions of China's economy, there are many ports in the Pearl River Delta region, which basically formed the core of the three huge ports, including Hongkong-international shipping center, Shenzhen-container trunk line port and Guangzhou-Southern China comprehensive main hub port, and a strong port group supplemented by medium-sized ports such as Zhuhai, Dongguan Humen, Huizhou (Yuan, Huang, & Wang, 2017, pp. 19-22). Through the close connection of the Pearl River water system, this ports have ensured the distribution and transfer of import and export containers, coal, oil products and grain in the Pearl River Delta, Guangdong Province and inland provinces, which made great contributions to the promotion of regional economic and social development.

Take container transport as an example. In 2016, the container throughput of Guangzhou Port and Shenzhen Port was 18,860 thousand and 23,980 thousand Twenty-foot Equivalent Unit (TEU) respectively. The container throughput of Hongkong Port is 19,630 thousand TEU, and the total of three ports was 62,470 thousand TEU, forming the status of a world-class port group (Ma, 2018, pp. 61-62).

Example of case: Guangzhou Port

In 2016, Guangzhou Port's cargo throughput and container throughput ranked sixth and seventh respectively in the world's ten largest ports. It is the largest comprehensive main hub port and container trunk line port in the Southern China area. The overall cargo throughput of Guangzhou Port in 2016 exceeded 5.2 million tons, ranked first in the Pearl River Delta region, and the container throughput ranked second. As a huge port of comprehensive domestic trade, regarding both container and dry bulk cargo as equally important, Guangzhou Port completed 5.85 million tons of cargo throughput in 2017, an increase of 41 million tons than in 2016. Container throughput was completed by 20,300 thousand TEU, an increase of 1,440 thousand TEU in 2016. Vehicle throughput was completed by 1,100 thousand vehicles, an increase of 32.1% over the same period, which was the first in Chinese main coastal ports (Gan, 2017).

2.3 The waters with crowded ships

The waters of PRE is the main marine outlet of Guangdong Province and Southern China area, the only waterway for huge ships to sail in and out of Guangzhou Port, and one of the central waters of China's shipping with intersected and complex channels. It is also an important communications centre of international shipping lane between China and foreign countries. According to relevant statistics, since the opening of foreign ships navigation to China, the international shipping passing through this waters has reached more than 1300 ports in 142 countries and regions (Huang, 2005). There are more than 4000 vessels sailing in the waters every day, and the annual traffic volume reaches about 1,500,000 vessels. In addition to merchant ships, there are more than 200 high-speed passenger ships travelling across the Pearl River Estuary every day.

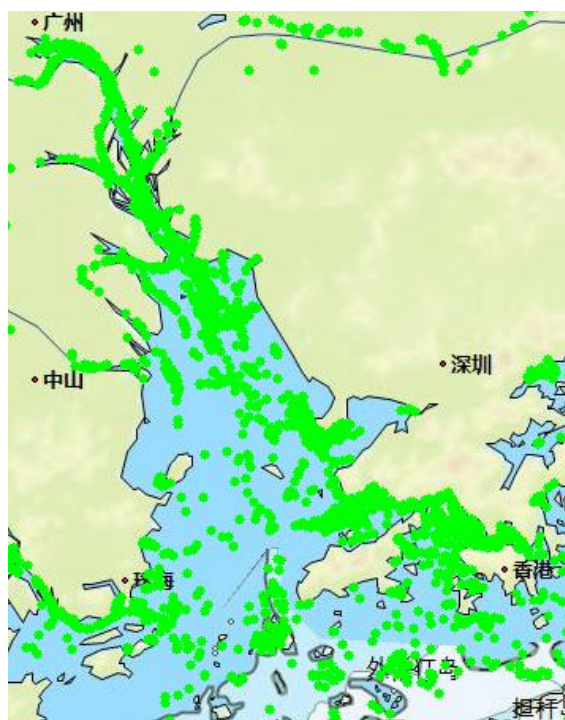


Figure 2 - Ships sailing in the waters of PRE (Source: www.shipxy.com)

In the vicinity of the Wanshan islands near the waters of PRE, due to the inflow of water from the Pearl River, which has brought rich bait, thus making it an important fishing ground along the coast of Southern China. During the season of fishing, a large number of fishing boats are fishing in the vicinity of Dangan Channel, Dahao Channel and Daxi Channel in the waters of PRE. The types and operation modes of these fishing boats are varied and their navigation is extremely irregular, which makes the traffic more complex in the waters (Lv, 2016, pp. 32-33).

2.4 The core waters of the Greater Bay Area

The Greater Bay Area, which includes nine cities of Guangdong Province - Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen and Zhaoqing - as well as the Hong Kong and the Macao, covers an area of 56,000

square kilometers, which accounts for 0.6 percent of the Chinese territory. Its economic output in 2016 hit 9.2 trillion yuan (US\$1.35 trillion), accounting for 12.4 percent of the national total. It is home to 68 million permanent residents, which is 4.9 percent of the population of China (Cai, 2017, pp. 5-14). All these characteristics meet the requirements for the establishment of another world-class Bay Area after New York Bay Area, San Francisco Bay Area and Tokyo Bay Area.



Figure 3 - The Greater Bay Areas (Source: www.sohu.com)

With the great adjustment of the world economic structure, New York Bay Area, San Francisco Bay Area and Tokyo Bay Area have been formed and rising one after another, with the main characteristics of finance, scientific and technological innovation and advanced manufacturing (Shen, & Yang, 2017, pp. 9-13). The advantage of the Greater Bay Area lies in its natural resources. It has a long coastline and huge international ports. Port economy is the engine of economic development in the bay areas, and the waters of PRE is the main waterway for huge ships entering and leaving the huge ports of this area. Therefore, it is an important prerequisite for

the promotion of the world-class Bay Area to enhance the navigation safety of the ships in the waters of PRE and create a first-class maritime SAR system.



Figure 4 - Famous bay areas in the world (Source: www.sohu.com)

CHAPTER 3

Analysis of ship accidents occurred in the waters of PRE

3.1 Ship accidents occurred in the waters of Guangdong in 2017

In 2017, there were 56 ships traffic accidents above the general level in the waters of Guangdong, with the loss of 46 lives and 19 ships, and a direct economic loss of 113,621 thousand yuan.

广东海事局机构和监控点布置图



Figure 5 - The jurisdiction of Guangdong (Source: www.gdmsa.gov.cn)

In 2017, the accidents occurred mainly in the waters of PRE and the inland waters of the Pearl River Delta, which accounted for 69.6% of the total number of accidents. Among them, there are 24 accidents occurred in the waters of PRE, 15 occurred in the inland waters of the Pearl River Delta, 7 occurred in East Guangdong waters, 5 occurred in western Guangdong waters, 1 occurred in North River and 4 occurred in West River.



Figure 6 - Locations of water traffic accident occurred in Guangdong jurisdiction in 2017

(Source: www.gdmsa.gov.cn)

3.2 Ship accidents occurred in the waters of PRE in 2017

Number	Date	Jurisdiction	Ship Name	Ship Type	Accident Type	Commanding MRCC	Departments participated in on-scene SAR	Ships participated in on-scene SAR	Number of people in distress	Number of people rescued
1	2017 0221	Zhuhai	13416	Fishing Vessel	Water Ingress	Zhuhai MRCC	Zhuhai MSA CFA BDF	HAXUN 09169 CFA 44190 BDF 44212	3	3
2	2017 0226	Zhuhai	GUIQINYU 12610	Fishing Vessel	Collision	Guangdong MRCC	Guangzhou MSA CFA NRB Fishing vessels	HAXUN 0933 NRB 116 CFA 44198-1 Rescue Helicopter GUIBEIYU 13018 GUIHEYU 83028	8	8
3	2017 0302	Guangzhou	GUOYUAN 18	Bulk Cargo Ship	Grounding	Guangzhou MRCC	Guangzhou MSA ShenZhuhaien Port	HAXUN 0929 CHIGANGTUO 1 CHIGANGTUO 2	22	22
4	2017 0418	Guangzhou	YUEDIAN5 7	Bulk Cargo Ship	Collision	MRCC	Guangzhou MSA Fishing Vessel	HAXUN 09077 HAXUN 09080 HAXUN 0929	8	8

			CCG 3062	Chinese Government Ship				YUEJIEYANGYU 22253		
5	2017 0519	Zhuhai	HAITUO80 6	Tug	Water Ingress (Sinking)	Zhuhai MRCC	Merchant Vessel	PAMPERO	8	8
6	2017 0714	Guangzhou	JIAYUAN1 9	Dry Cargo Ship	Engine room fire	Guangzhou MRCC	Guangzhou MSA NRB	HAIXUN 09079 HAIXUN 0929 NRB 116	6	6
7	2017 0823	Guangzhou	XINKE11	Oil Tanker	Sinking under the influence of Super Typhoon Hato	Guangdong MRCC	NRB GFS	NRB 116 Rescue Helicopter	14	14
8	2017 0823	Guangzhou	HUANNEN G8	Bulk Cargo Ship	Struck under the influence of Super Typhoon Hato	Guangdong MRCC	NRB	NRB 116	15	15
9	2017 0823	Guangzhou	KAISHUN YOU7	Oil Tanker	Grounding under the influence of Super Typhoon Hato	Guangdong MRCC	NRB	NRB 116	14	14
10	2017 0823	Guangzhou	GEMNO8	Oil Tanker	Grounding under the influence of Super Typhoon	Guangdong MRCC	NRB	NRB 116	15	15

					Hato					
11	2017 0823	Guangzhou	HONCHUN	Container Ship	Grounding under the influence of Super Typhoon Hato	Guangdong MRCC	NRB	NRB 101 NRB 102	21	21
12	2017 0823	Guangzhou	CHANGHA NGTANSU O	Oil Tanker	Grounding under the influence of Super Typhoon Hato	Guangdong MRCC	NRB	NRB 101	30	30
13	2017 0823	Guangzhou	SOLID2	Dumb Barge	Lose control under the influence of Super Typhoon Hato	Guangdong MRCC	GFS	Rescue Helicopter	3	3
14	2017 0823	Guangzhou	SHUNXIN9 96	Cargo Ship	Sinking under the influence of Super Typhoon Hato	Guangdong MRCC	NRB GFS	NRB 116 HUAQUAN Rescue Helicopter	13	12
15	2017 0823	Guangzhou	SE PANTHEA	General Cargo Ship	Grounding under the influence of Super Typhoon Hato	Guangdong MRCC	GFS	Rescue Helicopter	16	16

16	2017 0823	Guangzhou	RONGXIA NG66	Bulk Cargo Ship	Sinking under the influence of Super Typhoon Hato	Guangdong MRCC	GFS	Rescue Helicopter	11	4
17	2017 0823	Guangzhou	SOLID1	Tug	Sinking under the influence of Super Typhoon Hato	Guangdong MRCC	GFS	Rescue Helicopter	9	9
18	2017 0915	Zhuhai	YANGPO01 36	Fishing Vessel	Collision (YANGPO013 6 sinking)	Zhuhai MRCC	BDF Zhuhai MSA CFA Merchant Vessel	BDF 44211 HAIXUN 09169 CFA 44193 HUIWAN 302	8	8
			HUILONG HAI06	Cargo Ship						
19	2017 0803	Guangzhou	GLOBAL APOLLON	Oil Tanker	Collision (GLOBAL APOLLON water ingress)	Guangzhou MRCC	Guangzhou MSA Guangzhou Port	HAIXUN 09079 SUIGANGHUANB AO 1	0	0
			KOTA GANTENG	Container Ship						
20	2017 1015	Shenzhen	HENGHUI6 63	Bulk cargo Ship	Sinking	Shenzhen MRCC	Guangzhou MSA NRB	HAIXUN 0929 NRB 502 HUAYING 385 HUAQUAN	6	4
21	2017 1130	Zhuhai	QIONGDA NYU12108	Fishing Vessel	Engine Failure	Zhuhai MRCC	NRB	NRB 131	5	5

22	2017 1127	Guangzhou	SHUNJINL ONG	Bulk Cargo Ship	Collision (JINZE sinking)	Guangzhou MRCC	Guangzhou MSA NRB GSB Guangzhou Port	HAIXUN 0907 HAIXUN 09086HAIXUN 09118 HAIXUN 09108 HAIXUN 09111 HAIXUN 09102 NRB116 HUAYING 385 SUIGANGYIN 10 Rescue Helicopter	14	7
			JINZE							
23	2017 1201	Zhuhai	SHUNXIN1 88	Dry Cargo Ship	Collision (Sinking)	Guangdong MRCC	NRB CFA Merchant vessel	NRB 131 Rescue Helicopter CFA 44204-3 YINTONG YONGJI 23 HONGJI YUTIAN 6 HONGWAN 8 NANHAI 303 ZhuhaiESANYOU 301	10	10
24	2017 1218	Shenzhen	YUEZhuhai ANYU0110 3	Fishing Vessel	Water Ingress (Sinking)	Guangdong MRCC	Guangzhou MSA Zhuhai MSA NRB	HAIXUN 09079 HAIXUN 09080 HAIXUN 0929 HAIXUN 09076	4	1

							CCG BDF CMS	Haixun1462 Haixun 14204 NRB 502 CCG 44116 BDF 44127 BDF 44112 CMS 9006 CMS 90023-1 CMS 4404H Rescue Helicopter		
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Table 1 - Details of ship accidents occurred in the waters of PRE in 2017

(Source: Made by the author based on statistics from Guangdong MSA)

3.3 Analysis of the causes of high incidence of ship accidents in the waters of PRE

3.3.1 Intersection of ship routes

The inner waters of PRE belong to the river-Sea intersection water. The channels are tortuous and long, and connected with the numerous waterways of the Pearl River system. The ships entering and leaving the east and west side always cross the main channel. A large number of small ships cross and face encounter with large vessels sailing on the main channel frequently are more likely to cause accidents .



Figure 7 - Lingding Channel (Source: www.gzpgroup.com)

Accident Case:

On May 8, 2013, about 9.24 pm, in the voyage of crossing the Lingding Channel, Bulk Carrier Hexing 888 loaded sand and mud sailing from Hongkong to Macao, collided with Panamax Bulk Carrier EVERGLORY sailing from Dongguan to

Indonesia, in Lingding Channel. In this accident, six crew of Hexing 888 fell into the water, among them, three were rescued, one was killed and two were missing. The main cause of this accident is that under the condition of rainstorms and poor visibility, the crew of Hexing 888 did not drive carefully and crossed the main channel blindly without observing the surrounding environment.

3.3.2 Congestion of ships

There are many customary ship routes in the waters outside the PRE, which include both international and North-South routes. The ships sailing along these routes converge on this waters when entering and leaving the ports in the waters of PRE. Because of the large flow of ship traffic and the crossing of the channels, this waters is crowded, and a large number of ship traffic flows form head-on situation and crossing situation, which can easily cause collision accidents (Guo, & Fan, 2014, pp. 26-27).

3.3.3 Bad weather

According to the monthly statistics of the number of accidents in 2009-2015 years, the number of accidents in the waters of PRE from July to September and December to the following March accounts for 82% of the total number of accidents (He, & Cai, 2007, pp. 19-20). This is closely related to the bad weather in the time period.

From September to the following March, the waters of PRE is in the northerly monsoon periods. Especially in winter, the monsoon wind is strong and lasting for a long time. In this period, the general wind power reaches level 4-5, and the maximum wind power can reach level 9. The number of days in one month for wind power above level 6 can reach 7 days to 12 days. Due to strong wind, the cold wave

causes strong waves , which will have a great impact on ship navigation. In particular, it threatens the navigation safety of small and medium sized vessels, small container ships and sand and gravel carriers (Zhong, & Li, 2010, pp.169-172) .



Figure 8 - The waters of PRE in bad weather (Source: www.gzmsa.gov.cn)

According to the historical meteorological records of the coastal areas of Southern China, from August to November, there are many typhoons landing on Guangdong and Southern China. On average, there are one typhoon landing on the waters of PRE every year, 4-5 typhoons in some year (Hu, Du, & Luo, 2012, pp. 1-3). In 2017, there were 56 maritime traffic accidents under Guangdong MSA's jurisdiction, of which 17 wind disasters were caused by Super Typhoon Hato and one caused by Typhoon "Parka", accounting for 32.14% of the total accidents.

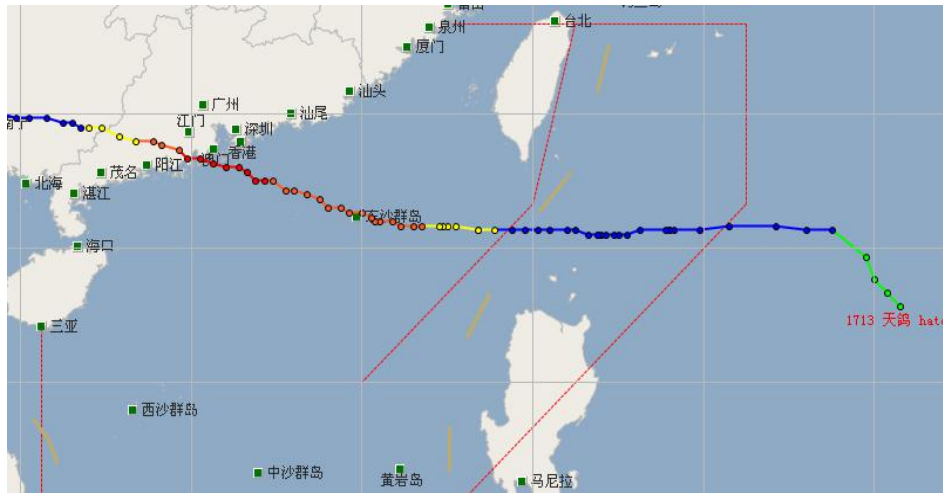


Figure 9 - The track of Super Typhoon Hato (Source:typhoon.nmc.cn/web.html)

Example of case: Super Typhoon Hato

At 12:50, in August 23rd, Super Typhoon Hato landed load on the coastal area of Zhuhai. The wind-force near the storm center was level 14 (45 m/sec). It brings strong storm surge and heavy rainfall. In particular, the waters of PRE was directly hit by Super Typhoon Hato, which posed a grave threat to the ships in this waters. It finally attacked 26 ships in the waters of PRE, Jiangmen and Zhongshan. There were 232 people in distress, 215 survivors were rescued, and 17 were killed and lost.



Figure 10 - The waters of PRE hit by Super Typhoon Hato (Source: www.gdmsa.gov.cn)

CHAPTER 4

Analysis of maritime SAR system in the waters of PRE

4.1 Guangdong MRCC

Due to the decentralization of jurisdiction, the ship accidents occurred in the waters of PRE are handled by Guangzhou MRCC, Zhuhai MRCC and Shenzhen MRCC, respectively. And because of insufficient SAR force of each MRCC, these accidents, especially major accidents, often require these MRCCs to participate in SAR operations together, which lead to Guangdong MRCC, the competent authorities at the higher levels of these three MRCCs, having commanded and coordinated most of the SAR operations in the waters of PRE. In brief, Guangdong MRCC is the major agency responsible for coordination and command of maritime SAR work in the waters of PRE.

MRCC	Guangdong	Guangzhou	Zhuhai	Shenzhen
Numbers of ship accidents	14	6	3	1
Proportion	58.3 %	25 %	12.5 %	4.2%

Table 2 - Quantity statistics of accidents occurred in the waters of PRE in 2017

(Source: Made by the author based on statistics from Guangdong MSA)

4.1.1 Brief introduction

The Guangdong provincial government and the Guangzhou Military Area Command have unified leadership over the maritime SAR work of Guangdong MRCC who is responsible for organization, coordination and command of marine emergency rescue work in Guangdong Province, such as taking precautions against typhoons and preventing marine pollution of ships and facilities and the maritime SAR work (Chen, 2008).

4.1.2 Regional cooperation

In order to strengthen the coordination and cooperation of the maritime SAR work, provide quick and efficient assistance to maritime accident, realize resource sharing and advantage complementation, and improve the emergency response capability of the maritime SAR in Guangdong and Hong Kong and Macao, Guangdong MRCC signed the "Guangdong-Hong Kong maritime SAR cooperation arrangement" and the "Guangdong-Macao maritime SAR cooperation arrangement" with the Hong Kong and Macao maritime SAR departments respectively (Chen, 2015, pp. 36-37). According to the above cooperation agreement, the three party's maritime SAR agencies adhere to the principle of "resource sharing , near fast, timely and effective and mutual help", and constantly strengthen cooperation to ensure the first time to mobilize the three party's SAR forces to participate in the rescue of the sea. It is precisely because of the above regional cooperation, the Hong Kong Government Flying Service (GFS) has taken part in a large number of maritime SAR operations in the waters of PRE and has made outstanding contributions .

4.2 Guangzhou MRCC

Guangzhou is the third largest city in China with more than 800 square kilometers of

administrative waters. Most waters of PRE, including the main channels, as well as the most dangerous waters, is under the jurisdiction of Guangzhou. From statistics, most areas of the ship accidents occurred in the waters of PRE are under the jurisdiction of Guangzhou.

Jurisdiction	Guangzhou	Zhuhai	Shenzhen
Numbers of ship accidents	16	6	2
Proportion	66.7 %	25 %	8.3%

Table 2 - Quantity statistics of the jurisdiction of accidents occurred in the waters of PRE in 2017

(Source: Made by the author based on statistics from Guangdong MSA)

4.2.1 Brief introduction

Guangzhou MRCC is a consultant and coordinating body in charge of Guangzhou Municipal Government. The office of Guangzhou MRCC is located in the Guangzhou MSA, which is specific to take the day to day work and the maritime SAR work of organization, coordination and emergency response (Xiong, 2016).



Figure 11 - The jurisdiction of Guangzhou MRCC

(Source: www.gzmsa.gov.cn)

4.2.2 Institutional framework

Guangzhou MRCC center is composed of the following members and departments.

Number	Institution	Responsibility
1	GZ MSA	Organizing and coordinating it's own ships and merchant ships to participate in maritime SAR operation.
		Maintaining the on-scene navigation order of operation.
		Issuing maritime traffic police
2	Publicity Department of the CPC Guangzhou Municipal Committee	Organizing, coordinating and supervising the publicity and reporting of disaster relief and news release.
		Organizing news media to report early warning and forecast information of disastrous weather, and the progress of the SAR operation
3	Industry and Information Technology Commission of Guangzhou Municipality	Coordinating basic operators' support for public communication network
4	Guangzhou Municipal Public Security Bureau	Organizing the police force to participate in SAR operation
		Maintaining SAR on-scene security order and implementing land traffic control
5	Bureau of Civil Affairs of Guangzhou Municipality	Ensuring the basic livelihood of the affected people and the disposal of the bodies of the victims.
6	Bureau of Finance of Guangzhou Municipality	Ensuring that the relevant maritime emergency funds, undertaken by the municipal finance, be included in the departmental budget of the financial year

7	Guangzhou Transportation Commission	Organizing land transportation support work for emergency rescue personnel, emergency relief supplies and rescue personnel
		Organizing transport companies to assist in the SAR work
8	Guangzhou Agricultural Bureau	Organizing and coordinating its force and fishing vessels to participate in the SAR operation
9	Health and Family planning Commission of Guangzhou Municipality	Organizing medical and health institutions to carry out medical rescue work, transfer of injured persons, and timely report the treatment of wounded
10	Foreign Affairs Office of Guangzhou Municipal Government	Coordinating the handling of foreign affairs and Hong Kong and Macao Affairs of consulates and officials
11	Guangzhou Administration of Work Safety	Assisting the MRCC in handling dangerous goods accidents
12	Guangzhou Public Security Fire Fighting Bureau	Organizing forces to carry out maritime fire fighting operations
13	Guangzhou BDF	Organizing and coordinating its force to participate in the maritime SAR operation
14	Guangzhou Emergence Office	Assisting the commander in charge of emergency handling of maritime traffic emergencies
15	Guangzhou Port Authority	Coordinating and organizing pilotage agencies, port and shipping enterprises to participate in maritime SAR operations

16	Guangzhou Meteorological Service	Monitoring and analyzing the weather situation, such as typhoon, haze, thunderstorm, cold wave, and so on, and provide the weather forecast information that may cause the accident of maritime traffic
17	Guangzhou Garrison Command	Organizing and coordinating the troops and Armed Police Force stationed in Guangzhou to participate in the emergency rescue work
18	Guangzhou branches of China Telecom, China Mobile , China Unicom	Providing maritime emergency communication support and timely transmitting early warning information to users
19	Gangzhou Port Group	Organizing its force to participate in the SAR operation
20	Nanhai Rescue Bureau	Organizing its force to participate in the SAR operation, and timely reporting the situation to the MRCC
21	Guangzhou Salvage Bureau of the Ministry of Transportation (GSB)	Organizing its force to participate in the SAR operation

Table 3 - Members of the Guangzhou MRCC

(Source: Made by the author based on statistics from Guangzhou MSA)

4.3 Nanhai Rescue Bureau

Nanhai Rescue Bureau of the Ministry of Transport (NRB), one of the national professional maritime rescue organizations, was established on June 28, 2003. NRB has 33 rescue vessels, including one 14000Kw tug, one 12000Kw tug, seven 8000Kw tugs, one 6000Kw tug, four catamaran high-speed rescue boat, and 22 rescue boats of other types. According to the latest deployment of CRS, these vessels are arranged at itinerant positions to carry stand by watch for the sensitive waters including the

waters of PRE, Qiongzhou Strait, and Xisha Islands. There are also three S-76D and two EC225 rescue helicopters deployed at on-duty locations in Zhuhai, Sanya respectively. In brief, NRB is the most professional maritime SAR force in the waters of PRE, and the unique department equipped with professional salvage ships (Liu, 2015).



Figure 12 - The locations of NRB Salvage Bases (Source: www.nh-rescue.cn)

The specialized rescue ships stationed in the waters of PRE are shown in the following table.

Ship name	Date of keel laid	Ship size	Load draught (m)	Main Power (KW)	GT (t)	Navigational speed (knots)	Drag force
NRB 101	2007.11	109×16.2×7.6	6.00	7000kW×2	4190	22	140t
NRB 116	2011.02	99.00× 15.2×7.6	6.00	4500kW×2	3681	20	105t

Table 4 - The details of specialized rescue ships stationed in the waters of PRE

(Source: Made by the author based on statistics from NRB)



Figure 13 - NRB 101 (Source: www.nh-rescue.cn)



Figure 14 - NRB 116 (Source: www.nh-rescue.cn)

Example of case: Maritime SAR operation in Super Typhoon Hato

In August 23, 2017, the Super Typhoon Hato land on Zhuhai, which affected many ships in the waters of PRE. The "NRB 101" and the "NRB 116" were on duty at the front of the typhoon. They were closely coordinated with the quickly mobilized "NRB 102", "NRB 111", "NRB 203", "Huaying 382", "Huaying 385", and successfully carried out 14 rescue missions during the typhoon, and helped 181 people in distress turn into peace.



Figure 15 - The SAR operation carried out by NRB in the Super Typhoon Hato

(Source: www.nh-rescue.cn)

4.4 Government Flying Service

The GFS is a department of Hong Kong with an establishment of 273 civil service posts responsible for flight operations, maintenance and administration. The GFS is located at the south-western corner of the Hong Kong International Airport. One of the major responsibilities of the GFS lies with SAR operations. Generally, the area of responsibilities covers up to 700 nautical miles (1300 Kilometers). Besides serving

Hong Kong, the department also assists in missions originated from the Guangdong MRCC. Air rescue operations in the waters of PRE, especially in bad weather, are basically carried out by the GFS (Xu, & Dong, 2016, pp. 57-58).

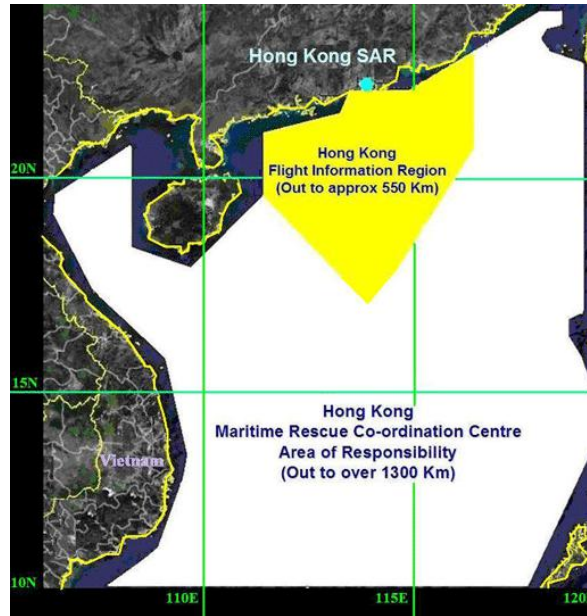


Figure 16 - Areas of Responsibility of GFS (Source:www.gfs.gov.hk)

The fleet of eleven aircraft comprises two Bombardier Challenger 605(CL605) fixed-wing aircraft, one Diamond DA42 twin engine fixed-wing aircraft, one Zlin Z242L fixed-wing aircraft, three Euro copter AS332 L2 (Super Puma L2) helicopters and four Euro copter EC155 B1 (EC155) helicopters.

Aircraft Name	Type	Maximum Weight	Cruise Speed (knots)	Radius of Action
Bombardier Challenger 605	Multi-purpose Aircraft	48,300 lb	425	700 nm with 4hr on scene time (MRCC AOR boundary)
EC155 B1	Medium utility transport helicopter	4850 kg	145	140 nm
Super Puma AS332 L2	Medium utility transport helicopter	9300 kg	140	200 nm

Table 4 - The details of specialized rescue aircraft equipped by GFS

(Source: Made by the author based on statistics from GFS)



Figure 17 - Bombardier Challenger 605 (Source: www.gfs.gov.hk)



Figure 18 - EC155 B1 (Source: www.gfs.gov.hk)



Figure 19 - Super Puma AS332 L2 (Source: www.gfs.gov.hk)

Example of case: Air SAR operation in Super Typhoon Hato

On 23 August, 2017, at 13:45, GFS was alerted by Hongkong MRCC that a Chinese cargo vessel had run aground against reef rocks and half sub-merged into the water about 15 nautical miles South West of Hong Kong. 14 crew members were reported in the water but believed to be wearing life jackets. Since the vessel was slanting, other rescue vessels were unable to get close to assist, the rescue mission can only rely on our helicopters.

Three helicopters were immediately deployed to the area and arrived on-scene at 14:22. The search area was located at the East of the severe typhoon Hato. Hence, the rescue area was affected by hurricane force winds with low cloud base and heavy rain with poor visibility. The sea state was rough with 10-14 meters swell. At 14:55 12 crew members were rescued by GFS helicopters, 2 are still missing. At 15:46, 1 person in water from another vessel was picked up by GFS helicopter. At 19:15, the SAR operation was temporary stopped. During the period, other vessels were found, near the shore, and 27 crew members were rescued. On 24 Aug 2017, after Severe Typhoon HATO has passed, GFS continued the SAR operations at the first light and rescued another 12 crew at Wanshan Island.

4.5 The existing problems of the maritime SAR system in the waters of PRE

4.5.1 The problem of the command system

In the handling of maritime emergencies in China, the principle of "Territoriality management, hierarchical response" is adopted (Liang, 2013, pp. 50-52). Guangzhou MRCC, for example, after receiving the ship accident report, occurred in the waters of PRE, shall immediately launch the contingency plan if the ship accident occurred

in the jurisdiction of Guangzhou MRCC, and shall immediately notify Zhuhai MRCC or Shenzhen MRCC and report to Guangdong MRCC at the same time. If this accident occurred out of the jurisdiction of Guangzhou MRCC. When carrying out the SAR work, if the SAR force is insufficient, Guangzhou MRCC shall request Guangdong MRCC for supporting, and Guangdong MRCC shall coordinate Zhuhai MRCC and Shenzhen MRCC send force to participate in the on-scene SAR operation. Such an ship accident response process caused by the decentralization of jurisdiction is complicated, which leads to poor communication and distortion of information, seriously affects the effectiveness of maritime SAR work.

4.5.2 The problem of the organization and coordination

Maritime SAR is a work that requires multiple departments to work closely together, such as the command and coordination department, the professional SAR department, the meteorological department, the maritime department, etc (Huang, 2014, pp. 72-75). Any problem in one link may lead to miss the best time to rescue. For instance, Guangzhou MRCC consists of 21 members, some of them belong to various ministries and committees of the central government, some of them belong to the functional departments of local governments. In maritime SAR operations, there may be the phenomenon of overlapping functions, unclear power and responsibility, and buck-passing. How to coordinate many departments and institutions orderly participation in maritime SAR is a problem that must be solved.

Example of case: 2016 PRE National Maritime SAR Exercise

On the morning of May 19, 2016, PRE National Maritime SAR Exercise was held in the waters near the Guishan Island. At the national level, 19 ministries and

commissions and their forces are involved in the exercise, including Ministry of transport, Ministry of foreign affairs, Ministry of industry and information technology, etc. There are 42 departments at the scene participating in the exercise, including the Guangdong MRCC's members, Department of Environmental Protection of Guangdong Province, Hong Kong MRCC, Hong Kong maritime Department, Macao Maritime and Water Bureau, Macao Customs, Shenzhen MRCC, Guangzhou MRCC, Zhuhai MRCC. The exercise on-scene used 35 ships, 4 aircraft and more than 1300 people.

4.5.3 The problem of the SAR equipment

The SAR forces in the waters of PRE are mainly composed of the government's official assistance force and the government's professional rescue force. The government's public assistance forces include MSA, CCG, CFA, BDF and so on. In the process of design and construction, the official ships of these departments did not consider the function of maritime SAR. And the ship is aging, the risk resistance capacity is poor. The government's professional rescue forces include NRB and GSB. Under severe weather conditions such as strong typhoons, only professional rescue ships belonging to NRB are available for on-scene rescue . But NRB has only two professional salvage ships and one helicopter deployed in the waters of PRE. The air rescue force in the waters is mainly responsible for the Hong Kong GFS.

4.5.4 The problem of lack of social SAR force

As can be seen from the above table, more than 3/4 of the ships participated in the on-scene SAR operations in 2017 in the waters of PRE come from the government, only less than 1/4 of the ships came from the social assistance resources, and frequently, they were just undertaking the simplest search work. The social maritime

SAR force has many advantages, such as large quantity, wide distribution and flexibility. It is an effective complement to the governmental SAR force (Yuan, 2012). At present, the participation of social forces in the on-scene SAR operations in the waters of PRE is temporary participation or mandatory assignment by the government. Social forces often face huge unexpected risks and economic losses when they participate in SAR, which seriously restrict the participation of social forces. Bur Guangdong MRCC and Guangzhou MRCC have not yet established the compensation mechanism to social forces participating in the SAR operation, and generally only give some symbolic rewards to the participation, mainly based on the spiritual reward.

Source	Ships					Aircraft	
	MSA	NRB	CCG , CFA and BDF	Fishing	Others	Guang Dong	Hong Kong
Number	23	18	13	3	13	4	6
Proportion	77.1%			22.9%			

Table 5 - Comparison of the source of the SAR force in the waters of PRE in 2017

(Source: Made by the author based on statistics from GFS)

CHAPTER 5

Foreign advanced maritime SAR systems

5.1 The maritime SAR system in USA

The whole waters of USA is divided into three areas: inland waters, coastal waters and high seas. The inland waters (i.e. inland river and Great Lakes) are managed by the Aviation Rescue Team assigned by the Air Force of Ministry of defense. The high seas area is commanded by foreign commander of the Naval and Air Force assigned by the Ministry of Defense. There are also national defense reserve teams and small naval fleets participating in SAR operations in various areas of inland waters. The US Coast Guard (USG) is the main body of the SAR system. It is not only the coordinator of SAR operations, but also the executor (Zhang, & Zhang, 2011, pp. 45-48).

The UCG responded quickly, with high standard and strong coordination ability. The effective rate of professional SAR is 93%, the effective rate of national SAR is 99%. 80% of the loss of property can be prevented by the UCG. After receiving the distress location information, the UCG will formulate an appropriate SAR response plan within five minutes. The decision to start working on the SAR operation can be made within fifteen minutes after the plan is made. Within 1.5 hours after the plan was made, the UCG can arrive at the scene of the distress (Jia, 2017, pp. 45-47).

5.2 The maritime SAR system in UK

The SAR work in the United Kingdom is running in a unique mode with the unified leadership of the strategic committee, the key coordination of the competent

authorities, and the close cooperation between the SAR organizations. The Strategy Committee is responsible for formulating macro management of SAR laws, policies, frameworks and standards. The MRCC is located in the Transport Department, which is under the responsibility of the Maritime and Coastguard Agency (MCA). The MCA has 19 HM Coastguards (HMCG) in charge of the specific tasks of maritime SAR work. In UK, the management method of maritime SAR work is not vertical, but flat, and the SAR operations are carried out by the HMCG without intervened by local governments (He, 2014).

Royal National Lifeboat Institution (RNLI) is a civilian SAR agency juxtaposed with the British government's SAR force. It is a volunteer service organization, currently has more than 5000 volunteers, can carry out emergency SAR mission within 100 miles away from shore. It sends ten thousands of SAR vessels and thousands of SAR personnel every year. It is an important reliance on British maritime SAR work. In addition, nearly ten thousands of volunteers from other social organizations participate in maritime SAR operations every year in UK. The British government also attaches great importance to the cultivation of social SAR forces. In addition to vocational training for HM Coastguard personnel, volunteers must be trained by special training institutions (Liang, 2014, pp. 73-75).

5.3 The maritime SAR system in JAPAN

Japan's maritime SAR work is undertaken by the Japan Coast Guard (JCG). The JCG, which belongs to the Ministry Of Land Infrastructure And Transport (MLIT), is a comprehensive maritime law enforcement agency, and carry out the functions of maritime safety management, maritime traffic management, maritime accident emergency rescue, maritime environment protection and so on. The JCG is well-equipped with more than 500 advanced marine patrol vessels and more than 70 planes on duty, and can carry out all-weather SAR missions. By implementing the management of Levels and Regions, Japan divides the maritime SAR area into 11 districts. Each district has JCG departments and agencies. The shore based radio

station set up along the coast can receive all kinds of dangerous information in real time, and can determine the location of the dangerous situation (Wang, 2008, pp. 18-20).

The personnel training and education mechanism and system is excellent in Japan, because there are Coast Guard Academy and relevant schools in Japan training a large number of excellent professionals for the SAR work. In addition, Japan's maritime emergency legal system is complete. Japan is an island country with relatively scarce resources and frequent natural disasters such as earthquakes, tsunamis and typhoons. In order to cope with frequent disasters, Japan has formulated a complete emergency legal system (Ma, etc, 2016, pp. 42-44).

5.4 Enlightenment of advanced maritime SAR system

5.4.1 Centralized management and organization

SAR command system is the "nerve center" of maritime SAR work, and its operation status directly relates to the success rate of SAR missions (Zhou, & Zhai, 2006, pp. 38-42). In USA, UK and Japan, UCG, MSC, and JCG have entire charge of maritime SAR work respectively. And there is no need to be controlled and coordinated by other departments. Through this management model, the command relationship is straightened out, the reaction plan at various levels is optimized and the SAR efficiency is improved through the development of the marines SAR decision system.

5.4.2 High socialization of SAR force

Although has a strong maritime SAR capability, the number of operations carried out by the UCG account for only 4% of the total numbers of USA. There are nearly 35000 volunteers in the UCG Volunteer team and volunteers for auxiliary work, accounting for 41% of all SAR personnel. The strong coordination ability of the UCG not only makes full use of the social SAR force, but also saves a large portion of the country's expenditure. The widely use of social force is another major feature of

Japan's maritime SAR system. 90% of the current maritime SAR work in Britain are carried out by social forces. The 400 maritime SAR teams and 3500 SAR volunteers, led by MCA, and more than 5000 volunteers from RNLI, provide sufficient human resources for the British maritime SAR work. In order to encourage the volunteers to give full play to the initiative of participating in SAR work, and improve the efficiency of the maritime SAR and reduce the cost of the state assistance, all these countries have set up various awards for the maritime SAR activities. These reward mechanisms have played a good role in promoting the work of maritime SAR in their own countries (Zhu, Li, & Li, 2010, pp. 39-42).

5.4.3 Advanced and sufficient SAR equipment

At present, there are seven types of long-range, medium-range, short-range fixed wing aircraft and 211 helicopters equipped by the UCG. Among them, the C-37A "Gulfstream V" long-range cruise fixed wing aircraft has a maximum range of 8851km and cruising speed up to 850km/h (450 knots). Meanwhile, the UCG has more than 2000 vessels for maritime safety supervision and SAR, which includes 247 large ships (65 feet and above) and more than 1850 small ships (65 feet or less). In addition, in 2006, USA developed and implemented a "comprehensive deep-water" plan for the modernization of its patrol vessels and aircraft, costing 25 years and \$42 billion. The JCG has 514 ships and 75 aircraft, including 29 fixed wing aircraft and 46 helicopters (Li, 2014).

5.4.4 High specialization of SAR force

Maritime SAR work of advanced countries is mainly based on social forces, but both equipment and personnel have reached the level of specialization. These countries have advanced maritime SAR education and training system. There are specialized universities and training centers improving trainees' ability and quality of maritime SAR through learning and practical training. Although the MCA currently has only 400 government staff engaged in maritime SAR, it has a large number of other

non-governmental organizations and volunteer teams (Dong, Ling, & Yu, 2014, pp. 39-32). There is no doubt that the government maritime SAR personnel must undergo special and regular training to ensure that all SAR skills are available. What's important, the volunteer teams are also carried out professional training by MCA or civil SAR organization. After training, they are regularly trained and assessed to ensure them keeping the ability of maritime SAR.

CHAPTER 6

Countermeasures of improving the maritime SAR system in the waters of PRE

6.1 Establishment of the PRE MRCC

The excellent maritime SAR command system is conducive to improving the efficiency of SAR work (Liu, 2010, pp. 47-49). Because of the decentralization of jurisdiction, the command of maritime SAR in the waters of PRE is not unified. MRCC in Guangzhou, Shenzhen and Zhuhai respectively conduct SAR coordination and command for ship accidents in their own jurisdictions, and Guangdong MRCC carry out this work in case of serious accidents, which reduces the SAR efficiency and increase the response time greatly. In light of this situation, as the Great Bay Area development strategy have been issued, it is urgently needed to reform the management system of maritime SAR work in the waters of PRE.

The Greater Bay Area should take the lead in breaking the administrative restrictions, integrate the maritime SAR departments and agencies in the waters of PRE, and establish the PRE MRCC. As a unified command and coordination agency responsible for maritime SAR work in the waters of PRE, the PRE MRCC can manage vertically, make decisions independently, unified command and action after the accident occurs. This can not only ensure the unity and coordination of maritime SAR, but also make full use of all aspects of resources and greatly improve the efficiency of SAR, thus ensuring the timely and effective handling of maritime emergencies. At the same time, it also helps to interconnect and share information resources among relevant SAR departments, improve the efficiency of maritime communication information transmission, shorten the time of emergency response, and strive for the best time for

maritime life salvage.

6.2 Establishment of an excellent maritime SAR legal system

Maritime SAR laws and regulations are not only the source of power and obligation of maritime SAR agencies, but also the basis for fulfilling their related duties (Yin, & Yan, 2015, pp. 31-39). In view of the problems of low level of legislation, poor authority, limited legal effect and lagging legal contents in China's maritime SAR, the Greater Bay Area should speed up the legislation on maritime SAR at the regional level. In particular, it should speed up the pass of the Regulations for Maritime SAR in the waters of PRE, so as to ensure that the SAR work in the waters of PRE has laws to follow, and is carried out in accordance with the law, thus giving full play to the maximum effectiveness of regional joint SAR. At the same time, the responsibilities of various departments should be clearly defined in the laws and regulations on maritime SAR, which can not only improve the efficiency of the maritime SAR work, but also avoid the situation of intersecting the functions.

6.3 Establishment of professional maritime SAR volunteer teams

At present, the construction of the maritime SAR volunteers has become an issue to which the countries all over the world pay more and more attention (Wang, & Sha, 2013, pp. 43-45). On the one hand, there are many ports in the waters of PRE, and the number of port ships is huge. The Greater Bay Area should make full use of the advantages of the world-class port group in the waters of PRE, integrate the port vessel resources, and establish a professional maritime SAR volunteer team, and make it an important supplement to the governmental SAR force. On the other hand, under the circumstances that the professional SAR force can not effectively cover the whole area of PRE, in order to cope with the accident quickly and timely and improve the success rate of rescue, the Greater Bay Area should make the most of the advantages of the merchant ships and fishing vessels, because absorbing social forces to participate in maritime SAR can effectively improve the capacity of maritime SAR work. In brief, the Greater Bay Area should make up for the shortage of governmental

SAR force by attracting social force, and establish the incentive system and training mechanism, so as to organize sufficient civil SAR force and enhance the coordination and operation ability of emergency management.

6.4 Establishment of a excellent maritime SAR voluntary service system

A excellent volunteer service system for maritime SAR is one of the signs of advanced of the the maritime SAR system (Huang, 2014). On the one hand, the Greater Bay Area should explore regional legislation to regulate activities related to maritime volunteer service, which clearly stipulates the recruitment, source of funds, equipment, reward mechanism, education and training of maritime volunteer service, so as to ensure the legitimate rights and interests of the volunteer service personnel in accordance with the law, and form a standardized support system for maritime SAR services. Thus ensuring that SAR volunteers participate safely, effectively and orderly in maritime SAR operations. On the other hand, the Greater Bay Area should take the lead in establishing the "PRE Maritime SAR Volunteer Fund". The fund should be managed and distributed by the PRE MRCC. The sources of fund can be donated through government subsidies, enterprises and individuals. The fund is mainly used to compensate and reward the cost of SAR volunteers, so as to establish a long-term mechanism. More importantly, this fund will provide the necessary material and safety guarantee for volunteers to participate in maritime SAR voluntary operation, which can mobilizes the enthusiasm of the whole society to participate in maritime SAR. In addition, the volunteers' personal accident insurance and the ship property insurance system should be set up.

6.5 Establishment of a excellent training system

The personnel skills and qualities are very important for the whole SAR work. In the case of using same rescue equipment, the SAR personnel with high professional quality and ability will be more efficient than ordinary SAR personnel (Liu, 2012, pp. 7-10). First of all, in order to improve the overall level of maritime SAR, the Greater Bay Area need to learn from the advanced experience of the UCG and JCG, and set

up special educational and training institutions for SAR crew and pilots, and provide highly practical and effective knowledge education and skills training for professional maritime SAR force and other social voluntary assistance forces. Thus, the skills and levels of the SAR personnel in the waters of PRE will be constantly improved, and a group of first-rate SAR personnel with solid SAR knowledge and proficient SAR skills will be trained. Secondly, the Greater Bay Area should actively organize professional SAR force and social forces to jointly carry out drill exercises on maritime SAR, which can make them learn and enhance maritime SAR capabilities in actual combat exercises. Last but not least, the Greater Bay Area should carry out technical training for volunteers and their organizations for free and the volunteer competition should be held regularly every year.

6.6 Upgrading and supplementing the SAR equipment

Emergency equipment and facilities reserve is the hardware guarantee for maritime SAR work. The experience of maritime SAR work shows that the effective disposal of maritime accidents depends largely on equipment and technology. First of all, in view of the fact that the number of specialized SAR vessels and planes in the waters of PRE is not enough, and the air rescue mainly depends on the HongKong GFS, the Greater Bay Area needs to expand the investment in maritime SAR equipment, and introduce and build a number of world-class rescue equipment. The SAR facilities should be rationally allocated to ensure that the rescue ships and planes in the waters of PRE are adequate in number, proportions and reasonable in layout. Secondly, the old ships should be eliminated in a planned way, and the age structure of ships and the overall performance of SAR ships should be improved. Thirdly, the relevant supporting equipment on SAR ships and planes should be improved, so as to ensure the maximum effectiveness of SAR equipment. Finally, the investment of rescue helicopters should be especially increased in the waters of PRE. Because the aircraft has quick reaction speed and strong maneuverability to enable it to quickly reach the mission area. In addition, the aircraft has the characteristics of good search field, long discovery distance, high search efficiency, little affected by the geographical features

and sea condition, and strong obstacle surmounting ability, which can make it reach the the unreachable sea area of other forces, thus having unique advantages in carrying out long or medium range maritime SAR missions.

CHAPTER 7

SUMMARY and CONCLUSIONS

Maritime transportation plays an irreplaceable role in human society. However, it is also an industry full of dangers and challenges. The risk of life danger for maritime employees and passengers is far greater than that of other industries. Maritime SAR, as the last line of defense for maritime safety, bears the sacred duty of ensuring the maritime safety of life and property. Maritime SAR is the cornerstone of the safety and security of sailing, also the prerequisite to the development of the transportation, as well as the dominant role in promoting harmonious development and efficient organization between every part of the sailing and transportation.

The natural condition of maritime SAR is extremely complex and changeable, and it is greatly influenced by various conditions such as weather, waves, tides and so on. The tasks to be undertaken are also very complicated and arduous, not only to ensure the maritime safety of life and property, but also to prevent damage to maritime environment and resources. Therefore, the successful organization of maritime SAR is inseparable from the knowledge and skills in many fields and aspects, which requires cooperation and linkage of multidisciplinary and many departments. Any link or problem may lead to miss the best time to rescue, resulting in huge casualties, property losses and destruction of environmental resources.

With the continuous development of the economic society, especially the maritime traffic and transportation, the disadvantages and limitations of the current maritime

SAR management system in the waters of PRE will become increasingly prominent., which will be a serious impediment to the development of maritime SAR and transportation, in front of the changing situation and task, if we insist on keeping it and not innovating. As the forward position of reforming and opening-up, the Greater Bay Area should explore the new maritime SAR system meeting the domestic requirement and adapting to the international situation.

Except for the world's leading economic and social management, the maritime SAR work in New York Bay Area, San Francisco Bay Area and Tokyo Bay Area is also the world-class. Since 2017, the development of Greater Bay Area has risen to a national strategy. If the Greater Bay Area wants to develop into a world-class Bay area matching even surpass the three largest bay areas. It should not only learn from the advanced social governance system, the economic development system, but also learn from the advanced maritime SAR system. It should seize the opportunity of development, make use of the advantage of policy and location, and dare to be the first to build an world-class maritime SAR system in China.

To sum up, the Greater Bay Area should improve the organization structure of maritime SAR system by establishment of the PRE MRCC, and make up the shortage of professional SAR force by attracting social forces and setting up incentive system, so as to organize sufficient SAR force and enhance the coordination and operation ability of emergency management. It also should establish a scientific training system for SAR personnel to make up for the lack of auxiliary system, speed up the process of maritime SAR related regional legislation in various ways, and gradually establish a excellent maritime SAR legal system, and fundamentally improve maritime SAR capabilities and emergency response speed by upgrading rescue equipment, especially professional SAR ships and helicopters.

REFERENCES

- Cai Chimeng. (2017). The strategic significance and realistic challenge of the construction of urban agglomeration in the Guangdong-Hongkong-Macao Greater Bay Area. *Guangdong Social Sciences* (4), 5-14.
- Chen Xianzhong. (2015). Hong Kong, Guangdong and Macao search and rescue cooperation. *Pearl River Shipping* (20), 36-37.
- Chen Yuanliang. (2008). Analysis and countermeasure research on the present situation of maritime search and rescue in Guangdong province. (Doctoral dissertation, Sun Yat-sen University).
- Dong Zhaohui, Ling Yu, & Yu Jing (2014). Construction of China's maritime search and rescue volunteer system. *Water Transport Management*, 36 (4), 29-32.
- Guo Weibin, & Fan Zhongzhou. (2014). The suggestion of revising the ship's fixed line system in the Dangan waters. *Navigation Technology* (2), 26-27.
- Gan Chao. (2017). Research on the development orientation of Guangzhou port under the background of "The Belt and Road Initiative". (Doctoral dissertation, south of south).
- He Jialin. (2014). British maritime Search and rescue system. *Chinese Disaster Relief Medicine* (3).
- Huang kehui. (2005). Study on the comprehensive evaluation of ship traffic in Pearl River based on VTS. (Doctoral dissertation, Shanghai Maritime University).
- Huang Qiuqiu. (2014). China's maritime search and rescue management system innovation from the perspective of governance theory. *China Navigation*, 37 (3), 72-75.
- Huang Zhiqiu. (2014). Research on China maritime search and rescue management system innovation (Doctoral dissertation, Wuhan University).
- He Huihua, & Cai Zesuan. (2007). Analysis of navigable environment and countermeasures of navigational safety in Pearl River Estuary. *China Shipping: Theoretical version*, 5 (12), 19-20.
- Hu Yamin, Du Yaodong, & Luo Xiaoling. (2012). Analysis of climatic characteristics of tropical cyclone in Pearl River basin in recent 50 years. *Guangdong Meteorology*, 34 (6), 1-3.

- Jia Shina. (2017). The comparative analysis of China-US maritime search and rescue public service capability. *China Water transport (second half month)*, 17 (8), 45-47.
- Kong Fancun, & Ruan Wei. (2004). Analysis of maritime search and rescue management system in China. *The waterway management*, 26 (7), 22-24.
- Liu Fang. (2015). Nanhai Rescue Bureau of the Ministry of Transport: Modern marine professional rescue team. *Guangdong Traffic* (3).
- Lin Feipeng. (2017). Improve navigation safety and efficiency of Pearl River Estuary. (Doctoral dissertation, Dalian Maritime University).
- Liu Gang. (2012) Suggestions for improving China's maritime search and rescue capability. *Water transport management*, 34 (4), 7-10.
- Liu Kairan (2010). Construction of a search and rescue volunteer team. *China Maritime* (8), 47-49.
- Liang Xiaocheng. (2013) Management of maritime search and rescue volunteers and its enlightenment to China. *China Maritime* (10), 50-52.
- Liang Xiaocheng. (2014). British maritime search and rescue volunteer management and its implications for China. *Navigation* (1), 73-75.
- Li, Y. (2014). Analysis of the research characteristics of american sar from the perspective of patents about sar applied in usa. *Tactical Missile Technology*.
- Lv Zhenyang. (2016). What are the reasons for the collision of the merchant and fishing vessels in Pearl River Estuary. *China Maritime* (12), 32-33.
- Ma Jinqi. (2018). The development of foreign trade container transportation in the Pearl River Estuary ports. *China Water transport* (1), 61-62.
- Ma Xiaoxue, Shi Shukai, Guo Yi, & Zhang Chengyao. (2016). Japan maritime search and rescue emergency system research. *China Water transport (second half month)*, 16 (3), 42-44.
- Shen Minghao, & Yang Yongcong. (2017) The revelation of the practice of the International Bay Area to the construction of the Great Bay Area. *Theory and practice of development reform* (7), 9-13.
- Wang Huan. (2010). Analysis of maritime search and rescue in China. *Tianjin navigation* (3), 59-61.

- Wang Ning. (2008). Japan maritime search and rescue and emergency response system. *China Emergency Rescue* (6), 18-20.
- Wang Wei, & Sha Xiaojin. (2013). Maritime search and rescue system problems and countermeasures. *Zheng He Studies* (3), 43-45.
- Xiong Gaofeng. (2016). Guangzhou maritime search and rescue emergency management capacity evaluation study. (Doctoral dissertation, Jinan University).
- Xu Wenmei. (2009). China's maritime search and rescue status and suggestions. *Water transport Management*, 31 (8), 35-38.
- Xu Dongsong, & Dong ke. (2016). Accelerate the construction of general aviation emergency rescue system. *International Air* (8), 57-58.
- Yuan Xitao. (2012) Research on the management of maritime search and rescue volunteers in China (Doctoral dissertation, Dalian Maritime University)
- Yuan Xiaopeng, Huang Daming, & Wang Chao. (2017). Comments on the present situation of Pearl River Delta Port Group development. *Traffic management*, 32 (6), 19-22.
- Zhou Mingyao. (2016). The 2016 Pearl River Estuary National Maritime search and Rescue exercise was successfully held. *China Maritime* (6), 6-11.
- Zhong Dongxiao, & Li Kaimin. (2010). The cause analysis and countermeasure of thunderstorm initiation accident in Pearl River Estuary. *Ship-Sea Engineering*, 39 (2), 169-172.
- Zhang Zhe, & Zhang Shouyue. (2011). Analysis of maritime search and rescue emergency rescue system in the United States. *China Emergency Rescue* (4), 45-48.
- Zhou Min, & Zhai Jiugang. (2006). Establishing an emergency management system for maritime search and rescue based on standardized management and innovative work ideas. *China Marine* (9), 38-42.
- Zhu Yuzhu, Li Qinrong, & Li Xiaowen. (2010). Reward mechanism for maritime search and rescue. *China Maritime* (12), 39-42.