Research Report on Navigation Status in the South China Sea, 2017

China Institute of Navigation

Shanghai Maritime University

June 2018

Editorial Board

Abstract

The South China Sea has always been the important waterway to the world for the coastal countries in history. In the new era, as the significant waters along the 21st Century Maritime Silk Road, the South China Sea is presently one of the busiest vessel traffic centers in the world, which has become a hot spot area with the world-wide attention. There have been some negative voices from the media and the countries overseas, which interfere with China's activities in the South China Sea and cause disturbance on Chinese diplomacy, economy and so on.

Presently, the conditions and situations in the South China Sea waters have developed towards a bright future. China, as a large shipping country, attaches great importance to the joint cooperation with adjacent countries, advocating the new safety and security principle with the mutual and integrated coordination and the sustainable development. China depicts the future of the South China Sea as with peace, friendship and cooperation based on the joint implementation of relevant international laws and conventions with countries in this area.

Experts and scholars from China Institute of Navigation and from Shanghai Maritime University have comprehensively explored, for the last successive two years, the actual vessel traffic conditions and situations in the South China Sea. Research findings have filled the international niche of vessel traffic safety and security statistics and analyses of the very area and have provided valuable references for authorities concerned. Detailed description is provided including the marine aids to navigation and the services to the safety of navigation in the South China Sea. Depth analysis includes island and reef distribution, strait waters, shipping regulations and rules, weather systems and recommended sea routes in the South China Sea. Moreover, in comparison with resources on the very sea route distribution and regular traffic methods, the benchmark data of the vessel traffic flow in the South China Sea are clarified based on the Satellite AIS data collection, statistics and analyses.

Findings of this research are as follow. In the South China Sea, the recommended routes are regularly and freely chosen by the large traffic flow of passing merchant ships and vessels with relatively big length, breadth, draft and with the average stable speed. The passing vessels with their registry ports covering about 70 major shipping countries and regions in the world represent more than 92% world capacities of 189 nations and regions (in terms of the overall tonnage of their respective top 50 fleets). Light houses and other public interest service facilities on islands and reefs are effectively safeguarding and serving the traffic in the South China Sea.

In conclusion, the research on the actual conditions and situations of navigation and on the benchmark data of the South China Sea show that the navigation in the South China Sea is unimpeded and safe with the scientifically-distributed and freely-chosen sea routes. The navigation guarantee in the South China Sea provided by China is necessary and reliable.

CONTENTS

CHAPTER 1 AN OVERVIEW OF THE SOUTH CHINA SEA WATERS 1

1.1EXTENT OF THE SOUTH CHINA SEA WATERS 1
1.2 ISLAND AND REEF DISTRIBUTION 3
1.3 NARROW CHANNELS 4
1.4 NAVIGATION RULES 4
1.5 WEATHER SYSTEMS 5

CHAPTER 2 ROUTES AND NAVIGATION GUARANTEE IN THE SOUTH CHINA SEA. 6

2.1 ROUTES IN THE SOUTH CHINA SEA 7
2.1.1 SOUTHWEST-NORTHEAST ROUTES 7
2.1.2 SOUTHEAST/NORTHWEST ROUTES 8
2.2 NAVIGATION GUARANTEE 8
2.2.1 VESSEL TRAFFIC MANAGEMENT AND SERVICE 8
2.2.2 EMERGENCY RESCUE IN THE SOUTH CHINA SEA 10

CHAPTER 3 ANALYSES OF AIS VESSEL TRAFFIC FLOW IN THE SOUTH CHINA SEA. 12

3.1 STATISTICS AND ANALYSES OF AIS VESSEL TRAFFIC FLOW IN THE SOUTH CHINA SEA 12
3.1.1 STATISTICS OF AIS VESSEL TRAFFIC FLOW IN THE SOUTH CHINA SEA 12
3.1.2 ANALYSES OF AIS VESSEL TRAFFIC FLOW IN THE SOUTH CHINA SEA 13
3.2 TRAFFIC FLOW OF MAJOR SHIP TYPES 16
3.3 VESSEL TRAFFIC FLOW PROPORTIONS OF THE CHINA COASTAL WATERS 17
3.4 SHIP REGISTRY DISTRIBUTION AND CAPACITY MAPPING IN THE SOUTH CHINA SEA 17
3.5 THE SOUTH CHINA SEA AIS DATA VALIDITY 24

CHAPTER 4 TRAFFIC SAFETY AND SECURITIES IN THE SOUTH CHINA SEA 26

4.1 TRAFFIC SAFETY AND SECURITIES PROFILE IN THE SOUTH CHINA SEA 26
4.2 FREE CHOOSING ROUTES IN THE SOUTH CHINA SEA 26
4.3 SAFE AND SECURE TRAFFIC IN THE SOUTH CHINA SEA 27

CHAPTER 5 CONCLUSIONS 28

REFERENCES. 29

Chapter 1 An Overview of the South China Sea Waters

1.1 Extent of the South China Sea Waters

The South China Sea, as named or identified in many international fields, is identified in various Chinese publications and written records as Nanhai. Hereinafter in this report referred to as the South China Sea.

Figure 1-1 Extent of the South China Sea
（From the 2017*Catalogue of Nautical Publications* by China Navy Hydrographic Office）

As shown in Figure 1-1, the South China Sea has broad and vast waters with the

main routes running from northeast to southwest. The Northern Coast of the South China Sea starts from the Nan'ao Island (about 24 ℃N) located on the coast of Guangdong Province, China, and extends southeast to the Bashi Channel; to its east are the western part of the Philippines Islands and the northwest coastal waters of Malaysia (Kalimantan Island); to the west the Beibu Bay and the east coast of Vietnam; to the south the waters with the latitudes of 4 ℃N～3 ℃N(near the south of the Zengmu Reef). The countries bordering the South China Sea include China, Vietnam, Philippines, Malaysia, Brunei, and Indonesia. With the very heavy vessel traffic, this area is presently one of the most important navigable waters in the world, and also attracts high world attentions. The South China Sea can be divided into four navigation areas according to the main routes and the features of navigable waters (Figure 1-2).

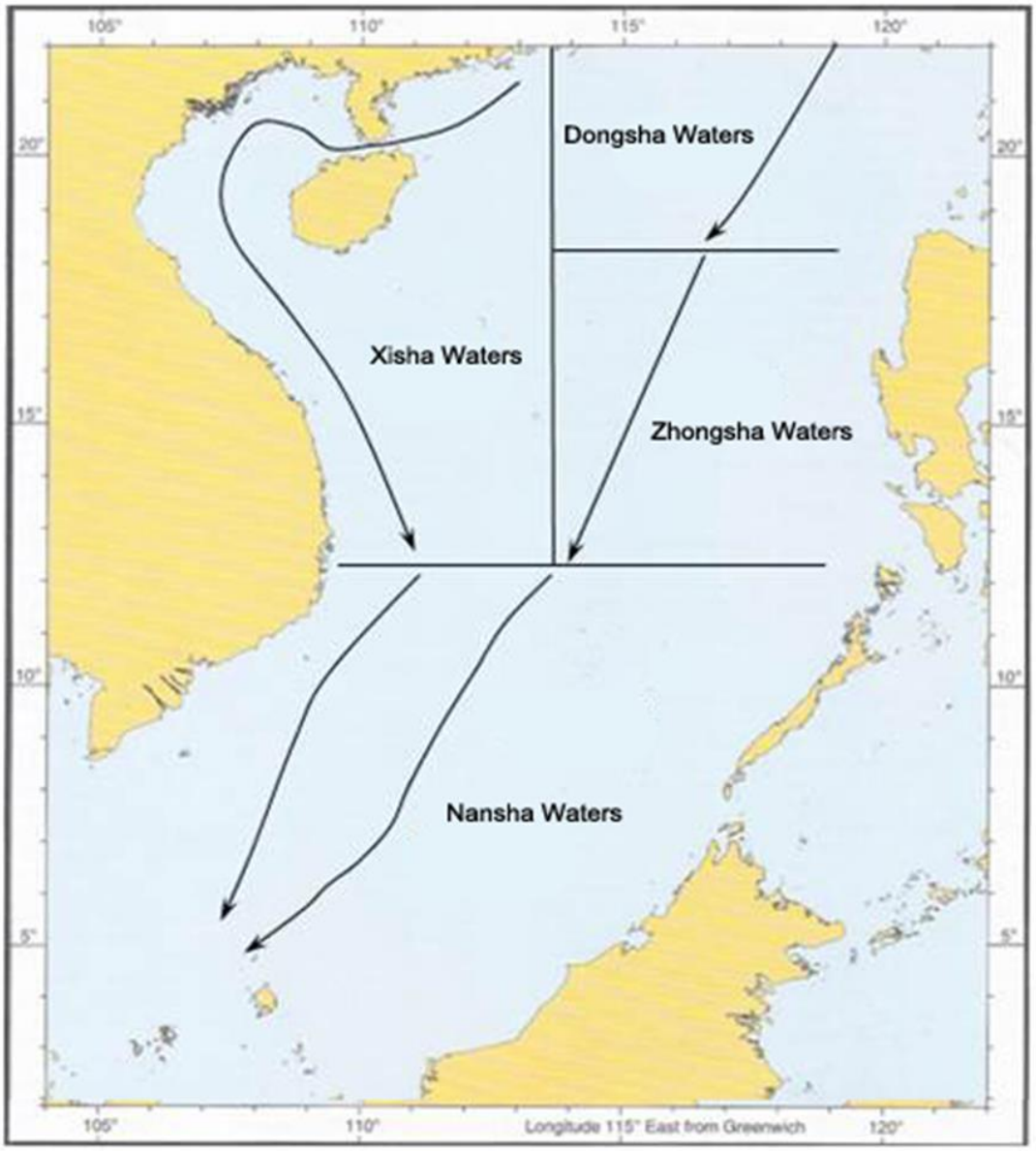

Fig. 1-2 Sketch map of navigation area divisions in the South China Sea

As shown in Figure 1-2, the four navigation areas are:

Dongsha and the surrounding waters (the latitudes 24 ℃N～19 ℃N,east of the

longitude 113°30′E, with the main waters of 20°20′N～21°20′N);

Xisha and the surrounding waters (the latitudes 22 ℃N～13 ℃N, west of the longitude113°30′E， with the main waters of 15°42′N～17°08′N， 111°10′E～112°54′E);

Zhongsha and the surrounding waters (the latitudes 19 ℃N～13 ℃N, east of the longitude113°30′E， with the main waters of 15°24′N～16°15′N， 113°40′E～114°57′E);

Nansha and the surrounding waters (the latitudes 13 ℃N～2 ℃N excluding the Thailand Gulf, with the main waters of 3°37′N～11°55′N，109 ℃33′E～117 ℃50′E).

1.2 Island and Reef Distribution

1) Island and reef distribution in Dongsha and the surrounding waters

Dongsha Qundao (the Dongsha Islands), located in the waters of 20°33′N～21°10′N，115°54′E～116°57′E, and in the middle of the Guangdong Province, the Hainan Island, the Taiwan Island and the Luzon Island of Philippines, are the northernmost islands among Nanhai Zhudao (the South China Sea Islands).

Dongsha Dao (the Dongsha Island) (20°42′N，116°43′E）is located in the west of the Dongsha Reef，2.8km from east to west, 0.7km from north to south, with the total area of about 1.8km^2，and the average altitude of 6 meters above sea level.

2) Island and reef distribution in Xisha and the surrounding waters

Xisha and its surrounding waters start from the Hailing Island to the west of the Pearl River estuary, extending westward to the Zhanjiang Port, the Qiongzhou Straits, through the Beibu Bay to the coastal waters of Vietnam, southward to the waters of Zhongjian Dao (the Zhongjian Island). Xisha Qundao (the Xisha Islands) lie in waters of 15°42′N～17°08′N，111°10′E～112°54′E, to the southeast of the Hainan Island, and in the middle of the South China Sea. Xisha Qundao (the Xisha Islands), one of the four archipelagos in the South China Sea, consist of the Xuande Islands, the Yongle Islands, the Huaguang Reef, the Dong Island, and the Zhongjian Island and etc., totally 22 islands, 7 sandbanks, and 10 reefs and hidden shoals, with the total area of 10km^2. Xisha Qundao (the Xisha Islands), centered at the Yongxing Island, is 180 nautical miles away from both the Yulin Port of the Sanya City and the Qianlan Port of the Wenchang City, China.

3）Island and reef distribution in Zhongsha and the surrounding waters

Zhogsha Qundao (the Zhongsha Islands) lie in the vast waters between Dongsha Qundao (the Dongsha Islands), Xisha Qundao (the Xisha Islands) and Nansha Qundao (the Nansha Islands), 600km from south to north and 440km from east to west. Zhongsha Qundao (the Zhongsha Islands) consist of the Zhongsha Grand Atolls, the Huangyan Island and other sporadic shoals, totally 1 island, 2 rocks, 2 submerged reefs, 26 underwater sand beaches and 2 hidden shoals, 33 of which have been named. Huangyan Dao (the Huangyan Island), centered at 15°07′N，117°51′.0E, is an exposed atoll with the form of an isosceles triangle, 15km long on both sides of the west and

the east, the total area about 150km^2.

4) Island and reef distribution in Nansha and the surrounding waters

Nansha and the surrounding waters lie in the area of 13 ℃～02 ℃, with the main waters of 3°37′N～11°55′N，109 ℃33′E～117 ℃50′E, in which Nansha Qundao (the Nansha Islands) are about 550 nautical miles from north to south and 650 nautical miles from east to west.

Nansha Qundao (the Nansha Islands), according to the island and reef distribution, can be divided into the eastern reefs, the western reefs and the southern reefs. There are a few scattered reefs in the east, submerged reefs and shoals in the south, and reefs and rocks all of the west. Among all the islands, (hidden) shoals, submerged reefs and underwater sand beaches totaling more than 550, Taiping Dao (the Taiping Island) is the biggest of 13 large islands.

1.3 Narrow Channels

The South China Sea and its surrounding waters have many world-famous straits and channels which are interlinked with adjacent seas and oceans. In the west, the Qiongzhou Strait is the inland sea of China, linking Guangdong coastal waters and the Beibu Bay; in the north, the Taiwan Strait northeast is the passage connecting the East China Sea and the South China Sea, east-wise, the Bashi Channel, the Balintang Channel, and the Babuyan Channel leading to the Pacific Ocean; in the east, there are the Mindoro Strait and the Balabac Strait leading to the Sulu Sea; and in the south, the waters are connected to the Andaman Sea by the Singapore Strait and the Malacca Strait, to the India Ocean by the Sunda Strait.

1.4 Navigation Rules

1) *United Nations Convention on the Law of the Sea* (UNCLOS)

The *United Nations Convention on the Law of the Sea*, the English version as well as the Chinese version, is the international agreement resulted from the third United Nations Conference on the Law of the Sea in 1982. UNCLOS defines such important terms as inland waters, territorial seas, adjacent seas, continental shelves, exclusive economic zones (also called "exclusive economic waters", EEZ), high seas and so on, which provides guidelines and regulations with respect to such issues as the marine natural resource management and pollution treatment and so on.

2）*International Convention for the Safety of Life at Sea* (SOLAS）

The *International Convention for the Safety of Life at Sea* (SOLAS）is an international convention established in a common agreement among the Contracting Governments with the uniform principles and the relevant rules for promoting safety of life at sea.

3) *2010 Manila Amendments to STCW Convention*

The *International Convention on Standards of Training, Certification and*

Watch-keeping for Seafarers (STCW) sets qualification standards for masters, officers and watch personnel on seagoing merchant ships. The implementation of the Convention contributes actively to the competency improvement of the Parties' seafarers, to the protection of safety of property, life at sea and of the marine environment, and to the effective control of the impact of human factors on marine accidents.

4) *International Regulations for Preventing Collision at Sea, 1972, as amended*

The *International Regulations for Preventing Collision at Sea,1972, as amended*（COLREGS）set out navigation rules to be followed by ships and other vessels at sea to prevent collisions between two or more vessels, thus maintaining the safety of navigation at sea.

5) *International Convention for the Prevention of Pollution from Ships 1973/1978*

The *International Convention for the Prevention of Pollution from Ships,1973/1978* (MARPOL73/78) is an international convention aiming at minimizing the pollution from ships' dumping pollutants, discharging oil into the sea, or emitting harmful gases into the air.

6) *International Ship & Port Facility Security Code (ISPS Code)*

The Diplomatic Conference on Maritime Security held in London in December 2002 adopted a serial of amendments to Chapter XI of the International Convention for the Safety of Life at Sea, 1974, as amended and the significant International Ship and Port Facility Security Code (ISPS Code). This Code establishes the role and responsibilities of the Contracting Governments, Government agencies, local administrations and the shipping and port industries, at the national and international level, for ensuring the maritime safety and security.

1.5 Weather Systems

The South China Sea are mainly affected by the monsoons (the northeast monsoon prevailing mainly from December to the following January, the southwest monsoon from May to August and the monsoon transition time for the rest) and from the tropical cyclones, storm surges and other weather systems.

The tropical cyclone season ranges from late June to mid-October each year with the most tropical cyclones moving to the southern coasts of China, others westward to the north of Vietnam.

According to statistics, the general moving pattern of the tropical cyclones is:

From November to April of the following year, mostly moving in the southern part of the South China Sea, mainly westbound; in May, mostly moving northeast, affecting the west coasts of the Guangdong Province, China or moving out of the South China Sea; from June to August, mainly moving northwards to northwestwards, and landing on the southern coasts of China; after September, mostly moving westwards; and more westerly in late October.

Chapter 2 Routes and Navigation Guarantee in the South China Sea

According to the current edition of *Ocean Passages for the World*[1], except for fishing activities, the recommended routes in the South China Sea mainly apply to the merchant ships sailing to/from ports in China, Japan, Korea, and Southeast Asian countries. These routes are mainly divided into the east routes, the middle routes and the west routes, running mainly with a direction of southwest-northeast, and the middle routes are identified as the main routes (Figure2-1).

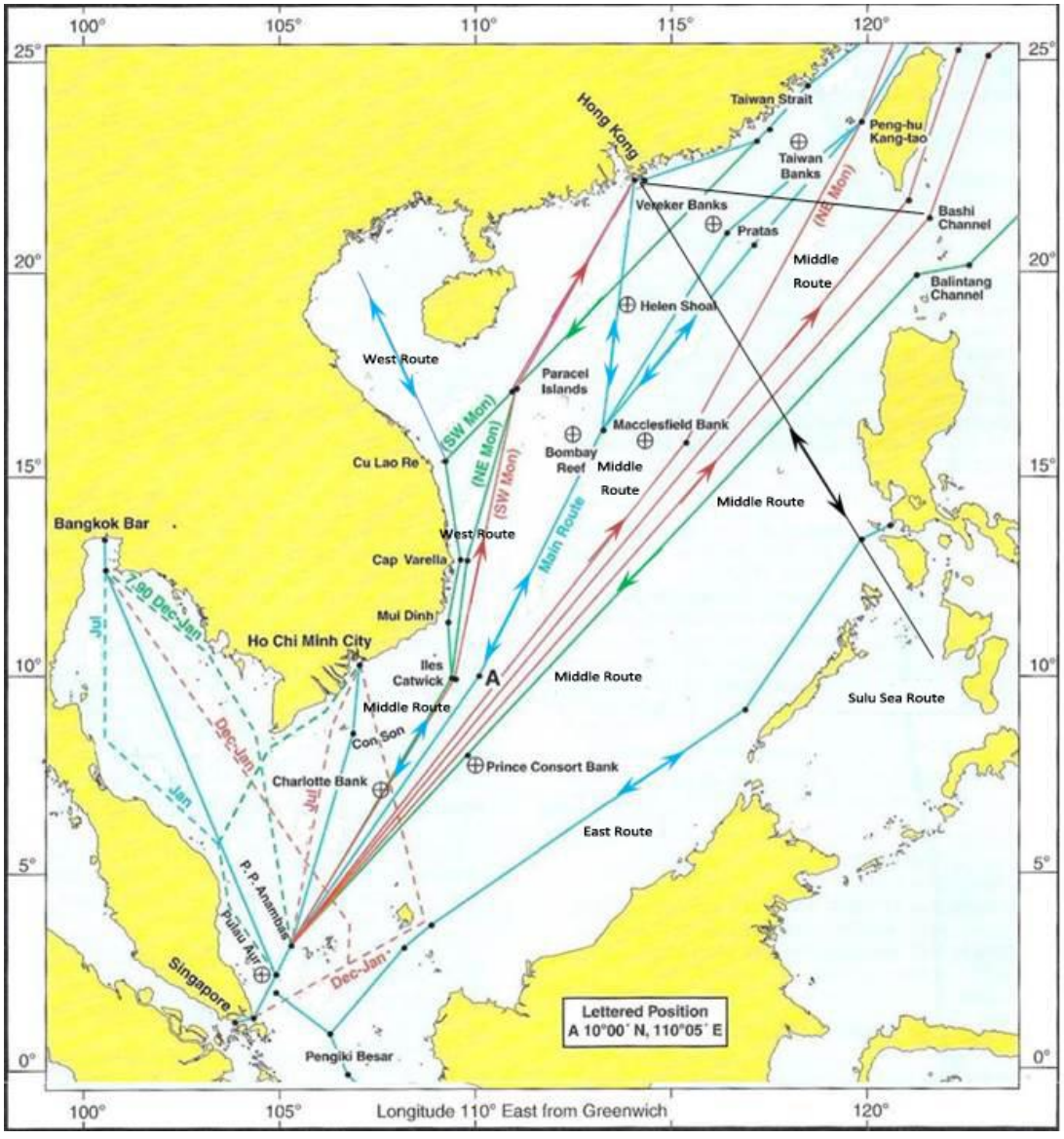

Figure2-1 Overview of the recommended routes in the South China Sea
(*Ocean Passages for the World* 2014)

[1]Geographic names in Figure 2-1 are only from the original charts and publications as of the publisher's.

2.1 Routes in the South China Sea

2.1.1 Southwest-northeast routes

1) East routes

During the northeast monsoon period (prevailing from December to the following January), certain low speed vessels may give priority to the choices of the east routes which are also called Palawan routes. The east routes are two-way routes: vessels sailing southwestwards along the South China Sea east coasts can reach the Philippine coastal ports or continue down south to Singapore; vessels can also sail from Singapore northeastwards along the Malaysian coastal waters to the Balabac Strait, and then reach the western coastal ports of the Philippines or continue northwards to the coasts of China, Japan or South Korea. Therefore, the east routes can lead to the Balabac Strait, the Mindoro Strait and the Verde Island Passage.

2) Middle routes（Main routes in the South China Sea）

Vessels sailing to/from China coasts, Japan and South Korea (including through the Taiwan Strait, the Bashi Channel) can select the middle routes in all seasons, which are the major international routes generally used by merchant ships. Vessels can sail north to south from either side of the Taiwan Banks (23°00′N，118°30′E) located in the southern part of the Taiwan Strait, passing through either side (the east or the west side) of Dongsha Dao (the Dongsha Island) (20°40′N，116°45′E) and directly proceeding to the position between the Maccelesfield Bank (15º50′N,114º30′E) and the Bombay Reef (16 º02′N,112º30′E) in the southern part of Xisha Qundao (the Xisha Islands,16°40′N,112 º00′E). Then the route can go to the position A(10º00′N,110º05′E), forward to the position 25 nautical miles southeast from the Charlotte Bank(7º08′N,107º35′E), destined for Singapore through the passage between the Aur Island (2º27′N，104º31′E) and the Anambas Islands(3º00′N,106º00′E).

During the northeast monsoon period(from December to the following January), vessels can also sail north to south from the Peng-hu Channel(23°30′N，119°53′) in the southern part of the Taiwan Strait, passing through the east of Dongsha Dao (the Dongsha Island) (20°40′N，116°45′E) and directly proceeding to the east of Zhongsha Tan (the Zhongsha Bank) (15º50′N,114º30′E). Then the route can go to the waters between the position A (10º00′N,110º05′E) and the Prince Consort Bank (7°53′N,110°00′) in Nansha Qundao (the Nansha Islands), forward to the waters 25 nautical miles southeast away from the Charlotte Bank (7º08′N,107º35′E), destined for Singapore through the passage between the Anambas Islands (3º00′N,106º00′E) and the Aur Island (2º27′N，104º31′E) .

The above are all two-way routes, i.e., vessels can reverse the routes sailing from Singapore to the Taiwan Strait or to Hong Kong, continuing northwards up through the Taiwan Strait or northeastwards through the Luzon Strait to the east of Taiwan.

3）West routes

During northeast monsoon period (from December to the following January) and southwest monsoon period (from May to August), vessels sailing in the South China Sea can take west routes. In addition, vessels sailing from the ports along the Beibu Bay or the Vietnamese coasts to Singapore can take west routes as well.

Vessels sailing from Hong Kong and the adjacent waters or from the south of the Taiwan Strait, directly to the position 30 nautical miles west of Xisha Qundao (the Xisha Islands) (16º40′N，112º00′E), can proceed to the position 15~20 nautical miles east of Cap Varella (12°54′N，109°28′E), to the east of Iles Catwick (10°00′N，109°00′E), and then to the position 25 nautical miles southeast away from the Charlotte Bank (7º08′N,107º35′E), destined for Singapore through the passage between the Aur Island (2º27′N，104º31′E) and the Anambas Islands (3º00′N,106º00′E).

Vessels sailing from the Singapore Strait via the South China Sea to the ports of China, Japan and South Korea, can proceed north up along those routes during these periods.

2.1.2 Southeast/northwest routes

The Mindoro Strait Route (southeast-northwest) is a route from Hong Kong and its adjacent ports to the South Pacific Ocean and Europe, and is also an important passage from the South China Sea to the Sulu Sea and Oceania. When the northeast monsoon is in transition or weak, the Mindoro Strait Route is commonly selected. Vessels from May to September sailing from Hong Kong to the South Pacific Ocean and Europe and in October from Europe to China, Japan usually pass through this strait.

In addition，there exists in this area an east-west route leading to the Bashi Channel or the Balintang Channel, which is also an important route from the southern ports of China to the Pacific Ocean (as is shown in Figure2-1).

2.2 Navigation Guarantee

The navigation charts and publications show the navigation guarantee has been developed especially in the northern part of the South China Sea with the advanced waterborne traffic management systems along the northern coasts, while there is the need for further improvement in the middle and the southern waters.

2.2.1 Vessel traffic management and service

1) Vessel Traffic System (VTS)

The ports in the South China Sea with VTS include the Hong Kong Port, the Shenzhen Port, the Guangzhou Port, and the Qiongzhou Strait Port, which can be referenced from *VTS User Guidelines* and *Radio Signal Tables*. There is not yet VTS in the middle or the southern part of the South China Sea.

2) China Ship Reporting System (CHISREP)

The China Ship Reporting System applies to the waters north of 9 ºN and west of

130 ℉, excluding the territorial sea and the internal waters of other countries. 300-tonnage and above China-registered ships sailing for more than 6 hours in the China Ship Reporting Area shall report to CHISREP; foreign registered ships and China-registered ships below 300 tonnages may volunteer to report. There is no requirement for the ship reporting system in the waters south of 9 ℕ and east of 130 ℉.

3) Marine aids to navigation

At present, China has built five large-scale multifunction light houses on islands and reefs of the Nansha Islands, that is, the Huayang Reef, the Chigua Reef, the Zhubi Reef, the Yongshu Reef and the Meiji Reef (Figure 2-2).

These five lighthouses are important public interest service facilities built by China in the South China Sea providing such navigation guarantee as maritime search and rescue, services for the safety of navigation and fishery and the prevention of marine disasters, which represent the implementation of relevant international responsibilities and obligations on the part of China as an IMO member state.

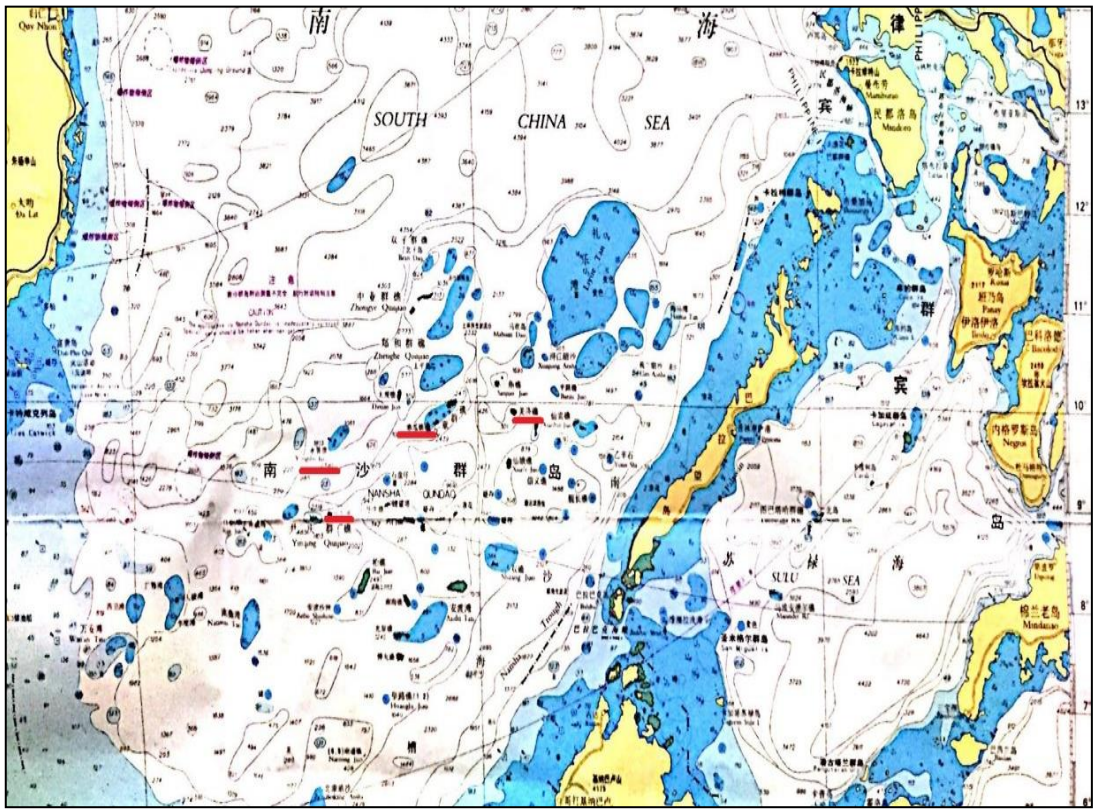

Fig.2-2 Island and reef distribution in Nansha Qundao (the Nansha Islands) waters

4) Radio Navigational Warnings

Navigational Telex (NAVTEX) stations in the South China Sea can be referenced from Table 2-1 as follows:

Table 2-1 NAVTEX in the waters from the South China Sea to Singapore

No.	Country（Region）	Station Name	Location	Code
1	China（Hong Kong）	Hong Kong	22°11′ N,114°15′E	L
2	China（Guangzhou）	Guangzhou	23°09′ N,113°30′E	N
3	China（Sanya）	Sanya	18°14′N,109°30′E	M
4	Vietnam（Da Nang）	Da Nang	16°03′.53N,108°12′.53E	K
5	Vietnam(Ho Chi Minh City）	Ho Chi Minh City	10°23′.53N,107°08′.95E	X
6	Malaysia (Sandakan）	Sandakan	5°54′ N,118°00′E	S
7	Malaysia（Miri）	Miri	4°26′ N,114°01′E	T
8	Singapore (Changi)	Singapore（Changi）	1°21′ N,103°59′E	C

2.2.2 Emergency rescue in the South China Sea

In accordance with the *IMO International Convention on Maritime Search and Rescue*, Hong Kong (China) reported to IMO with regard to the search and rescue area in the South China Sea as north of 10 ℃N, west of 120 ℃E excluding other countries' sovereign sea.

In 2006, the State Council of the People's Republic of China promulgated the *National Emergency Plan for Maritime Search and Rescue*, which plan applies to "the emergency response to marine distresses in Chinese maritime jurisdiction waters and in search and rescue responsibility waters".

China has the fairly developed capabilities with the effective search and rescue centers along China's southern coasts and the watchkeeping stations on Yongxing Dao (the Yongxing Island) of the Xisha waters. Meanwhile, other coastal countries around the South China Sea have relatively limited capabilities with their search and rescue centers covering only coastal waters. China is therefore apt for setting up permanent search and rescue stations with the pollution-prevention function on proper islands to promote the safety guarantee in the South China Sea.

In the period of 2016-2017, China conducted 25 rescue tasks (11 times in 2016, 14 times in 2017), dispatching professional rescue forces 37 times (with 12 ships and boats, 25 helicopters), rescuing 5 ships (with 2 of foreign registry) and 138 persons in distress (with 15 of foreign nationality) with the saved total property value worth RMB 256 million.

On 31st October 2017, China and ASEAN countries held a joint maritime search and rescue drill in waters off Zhanjiang port, Guangzhou Province, China. This is the largest-ever joint maritime search and rescue drill China and ASEAN countries have held to date. Task coordinators, search and rescue teams, evaluation specialists, liaison officers from China, Philippines, Thailand, Cambodia, Laos, Myanmar and Brunei participated drill activities including directing, coordinating, rescuing, evaluating, inspecting and so on.

China is now and will go on actively promoting the practical cooperation of

maritime search and rescue in the South China Sea between China and ASEAN countries, which aims at the mutual understanding and the improvement of joint search and rescue capabilities through effective coordination and collaboration.

Chapter 3 Analyses of AIS Vessel Traffic Flow in the South China Sea

3.1 Statistics and Analyses of AIS Vessel Traffic Flow in the South China Sea

Navigation areas in the South China Sea are specifically characterized and mutually connected. The remarkable differences among navigation areas such as island and reef distribution, water depth, wind flow, port resources, anchor conditions and regular navigation and etc. place great demands on the steering in terms of navigation area features and precautions for sailing. Therefore, the satellite AIS data statistics is an important way to obtaining the vessel traffic flow and to the scientific clarification of navigation freedom in the South China Sea.

3.1.1 Statistics of AIS vessel traffic flow in the South China Sea

Considering the eminent monsoon climate in the South China Sea, the vessel traffic flow is significantly relevant to the monsoon, and the navigation activities show yearly cyclical features. Statistical results of the merchant vessel traffic flow data in March (with the NE monsoon), June (with the prevailing SW monsoon and the cyclone), 2017 from the low-orbit satellite AIS database are shown as figures from 3-1 to 3-4.

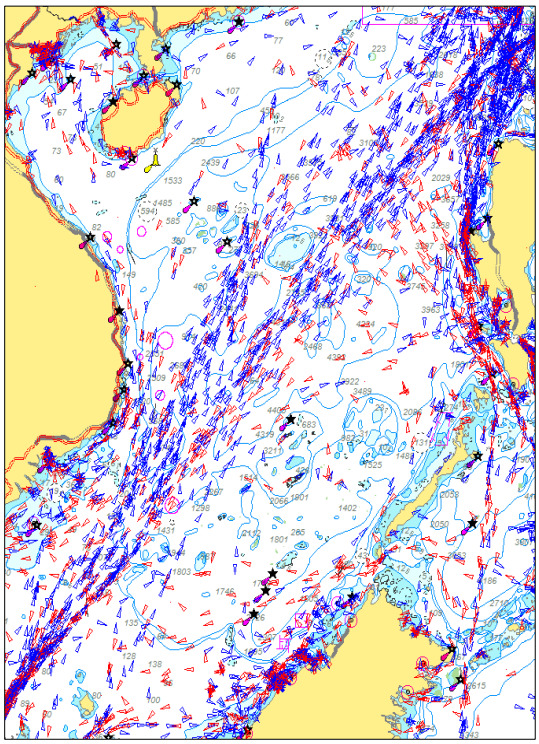

Fig 3-1 Ship position graph in March 2017

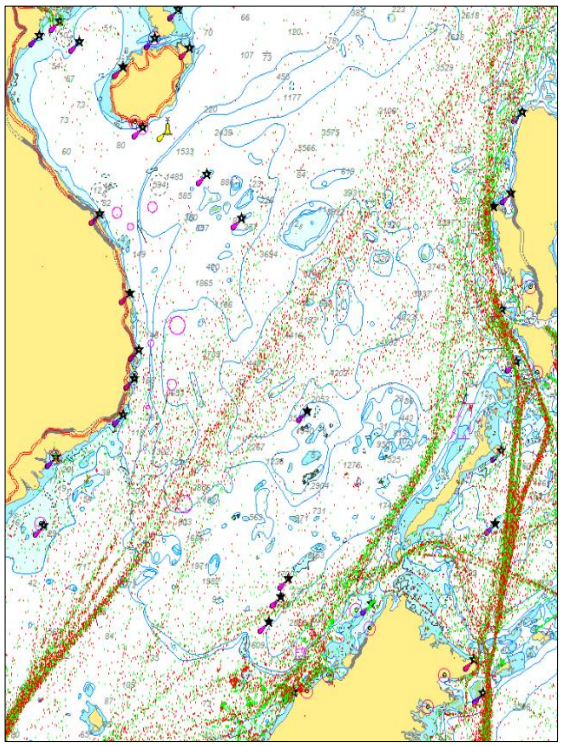

Fig 3-2 Ship trajectory (route) graph in March 2017

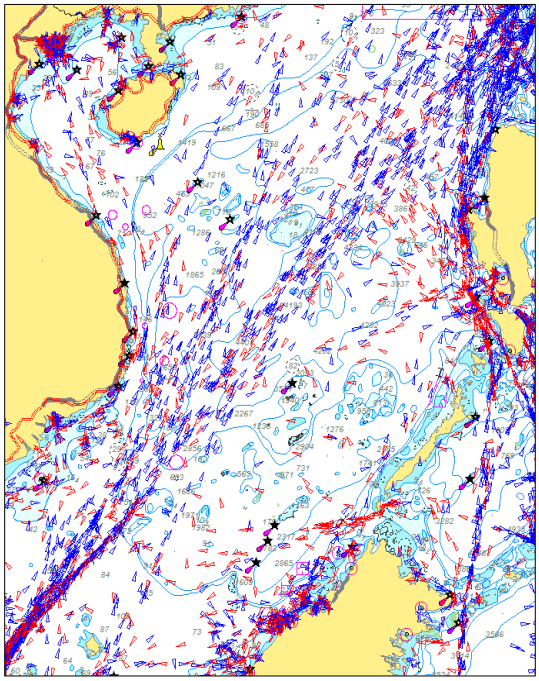

Fig 3-3 Ship position graph in June 2017

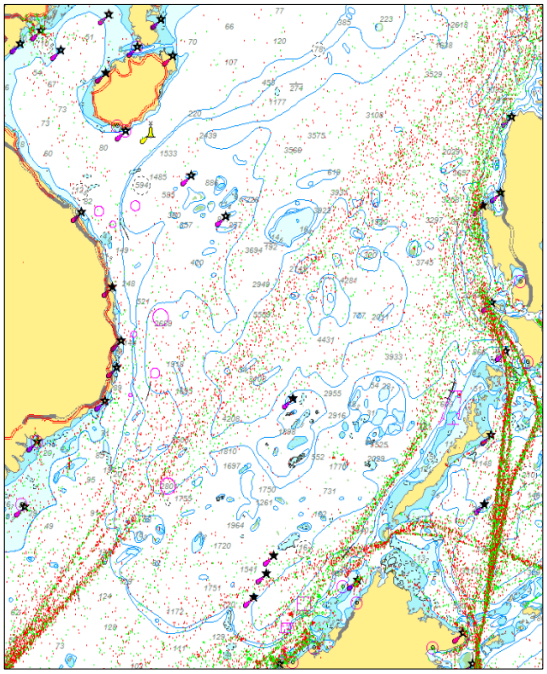

Fig 3-4 Ship trajectory (route) graph in June 2017

3.1.2 Analyses of AIS vessel traffic flow in the South China Sea

The ship position and trajectory graphs show vessels sail in and out the South China Sea mainly from the Beibu Bay, the Taiwan Strait, the Bashi Channel, the Mindoro Strait, the Balabac Strait and from the Malacca Strait.

Table 3-1 Positions of the vessel traffic flow observation planes

Observation plane	Coordinate
1#	11°27′22.44″N，114°12′47.70″E 14°15′00.00″N，110°01′49.25″E
2#	10°52′39.79"N，118°41′45.28"E 12°08′26.95"N，117°24′05.50"E 13°24′40.39"N，116°43′12.98"E 15°21′48.43"N，113°54′48.60"E 16°02′11.69"N，112°07′43.01"E 16°26′40.64"N，109°50′22.54"E 15°55′52.11"N，108°22′54.15"E
3#	18°39′58.93"N，120°50′55.24"E 19°49′51.61"N，118°46′39.59"E 19°54′30.05"N，110°55′46.57"E
4#	18°39′58.93"N，120°50′55.24"E 21°49′44.97"N，120°51′44.29"E
5#	13°04′53.37"N，120°38′57.66"E 12°23′45.27"N，119°50′45.50"E
6#	5°08′56.27"N，105°39′56.78"E 3°35′23.60"N，107°56′11.84"E 2°58′08.73"N，108°44′42.16"E

For the sake of the AIS statistics, six AIS data observation planes are set for the detailed analyses of the vessel traffic flow distribution in the South China Sea. See Table 3-1 and Fig. 3-5 for observation plane details.

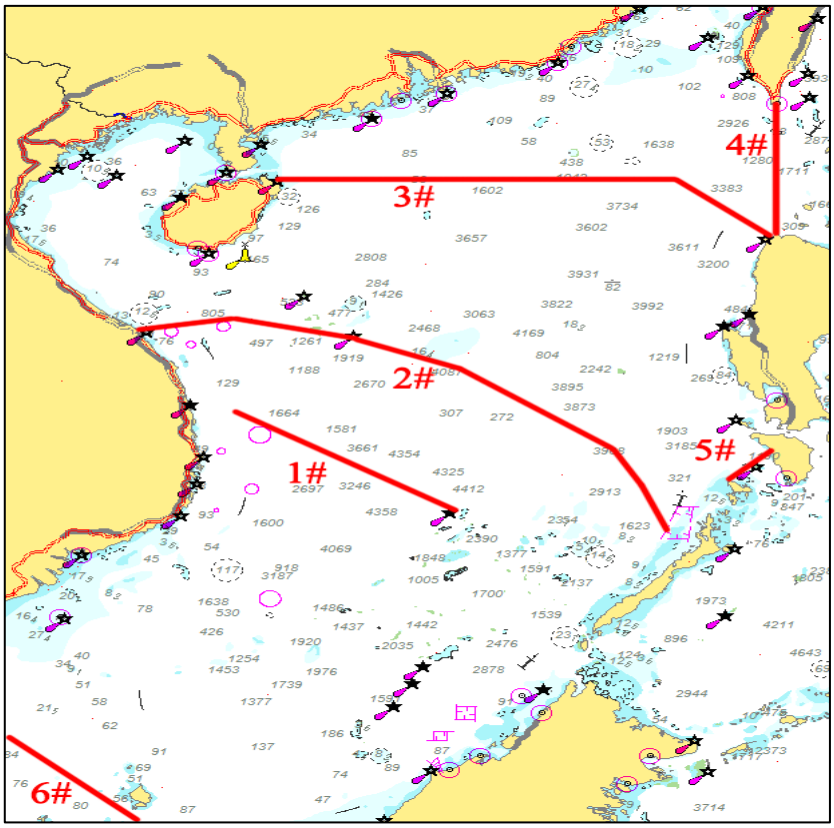

Fig. 3-5 Distribution of the vessel traffic flow observation planes

The nature of the vessel traffic flow in the South China Sea is determined by the AIS vessel traffic flow statistics of various observation plane positions and cross-sections and of vessel sailing directions. For the sake of consistency, the northbound and eastbound vessels are taken as of the entrance direction. Detailed analyses are as follow.

1) AIS vessel traffic flow statistics of March 2017

According to the AIS statistics, the total number of vessels in the South China Sea in March 2017 is 7907.

The waters in the South China Sea are divided into 213 grids at the scale of 80000m×80000m to get the ship density (See Fig. 3-6). Statistics of the ships passing the grid in unit time show the total number as3615, with the unit maximum of 618.

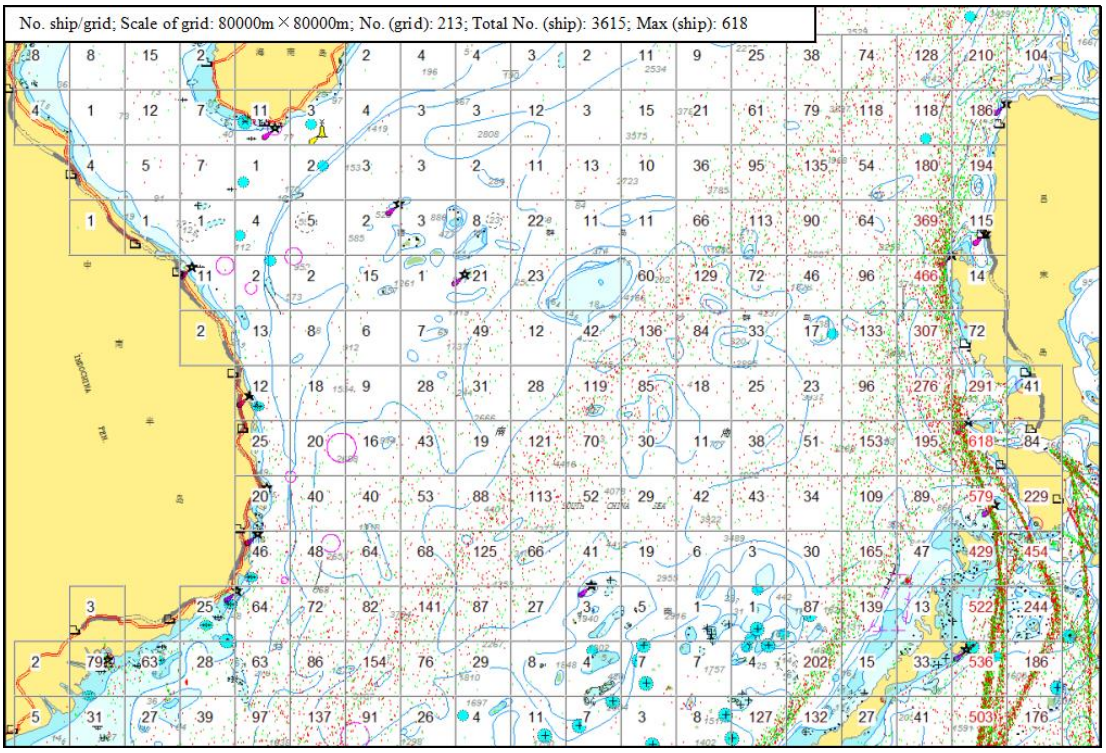

Fig. 3-6 In-grid AIS ship number trajectories (in unit time)

2) AIS vessel traffic flow statistics of June 2017

According to the AIS statistics, the total number of the ships in the South China Sea in June 2017 is 7771.

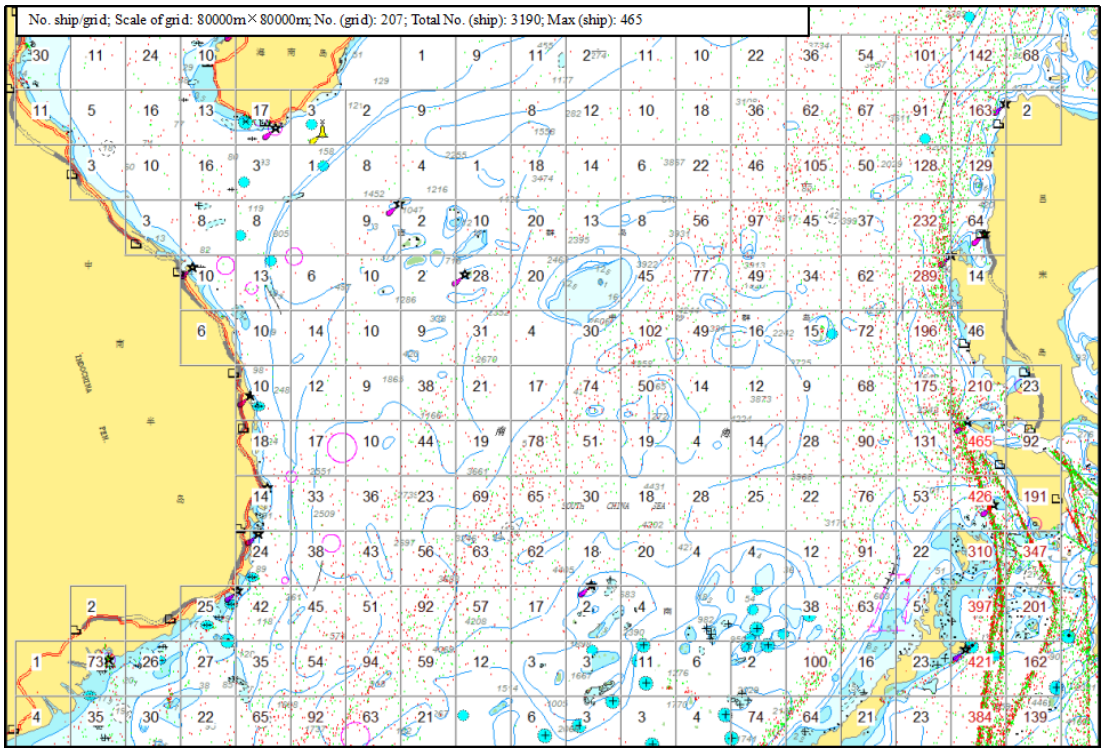

Fig. 3-7 In-grid AIS ship number trajectories (in unit time)

The waters in the South China Sea are divided into 207 grids at the scale of

80000m×80000m to get the ship density (See Fig. 3-7). Statistics of the ships passing the unit grid in unit time show the total number as 3190, with the unit maximum of 465.

3.2 Traffic Flow of Major Ship Types

The vessel traffic flow feature analyses are also made based on the AIS statistics about ship type across different observation planes.

1) Statistics of AIS vessel traffic flow in the South China Sea in March 2017

The AIS statistics on 1#～6# observation planes in March 2017 are shown as Table 3-2.

Table 3-2 Statistics of March 2017 on1#～6# observation line

Observation Line	No. of vessels	Average ship length(meter)	Average ship breadth (meter)	Average draft	Average passing speed (knot)
1#	1930	222.6	35.6	10.7	13.5
2#	2035	215.8	34.9	10.4	13.4
3#	2458	216.8	34.9	10.4	12.9
4#	1293	228.9	37.2	11.1	13.2
5#	1245	201.9	32.1	9.0	11.9
6#	2931	206.8	33.0	9.8	13.1

2) Statistics of AIS vessel traffic flow in the South China Sea in June 2017

The AIS statistics on 1#～6# observation planes in June 2017 are shown as Table 3-3.

Table 3-3 Statistics of June 2017 on 1#～6# observation line

Observation Line	No. of vessels	Average ship length(meter)	Average ship breadth (meter)	Average draft	Average passing speed (knot)
1#	1745	219.0	34.8	10.5	13.4
2#	1786	214.8	34.3	10.2	13.3
3#	2073	219.9	35.2	10.5	13.0
4#	1078	236.2	38.2	11.4	13.3
5#	1025	209.0	33.2	9.4	11.9
6#	2623	205.8	32.7	9.7	13.2
Note: There was no tropical cyclone in the South China Sea in June, 2016. Due to the effect of the tropical cyclone happening during 12th to 16th June 2017 (Name: MERBOK; Central pressure: 984hpa), there was a decrease of ship numbers.					

3.3 Vessel Traffic Flow Proportions of the China Coastal Waters

The major vessel traffic flow in China coastal waters (within 12 nautical miles from the Hainan Island and from the Nanhai Islands and Reefs), mainly of the vessels in and out these islands, is analyzed based on the statistics of AIS vessel traffic flow, combined with those of grid vessel traffic flow, in the South China Sea in March and June 2017. Results are shown as Table 3-4 and Figure 3-8.

Table 3-4 Proportions of the major vessel traffic flow in and out islands and reefs of the China coastal waters, the South China Sea

Time	Total vessel traffic flow (ships)	Major vessel traffic flow in and out islands and reefs of the China coastal waters(ships)	Proportion
March, 2017	7907	188	2.38
June, 2017	7512	203	2.70
Average (monthly)	7710	195.5	2.54

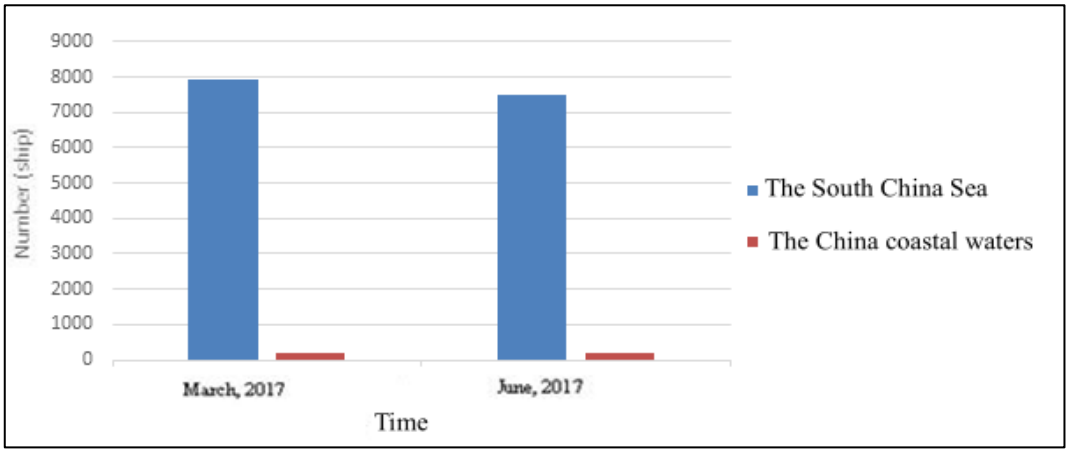

Fig. 3-8 Contrasts between the major vessel traffic flow in the China coastal waters and the total vessel traffic flow in the South China Sea

As seen from Table 3-4 and Figure 3-8, the average proportion of the vessel traffic flow in the China coastal waters to that in the South China Sea is 2.5%, which means little vessel traffic flow in the island and reef area. The 97.5%majority of the ships sail through the open areas of the South China Sea.

3.4 Ship Registry Distribution and Capacity Mapping in the South China Sea

1) Registry distribution in the South China Sea

Vessel registry (country/region of registration) distribution is calculated based on the satellite AIS statistics of March and June, 2017, as is shown in Figure 3-9 and 3-10.

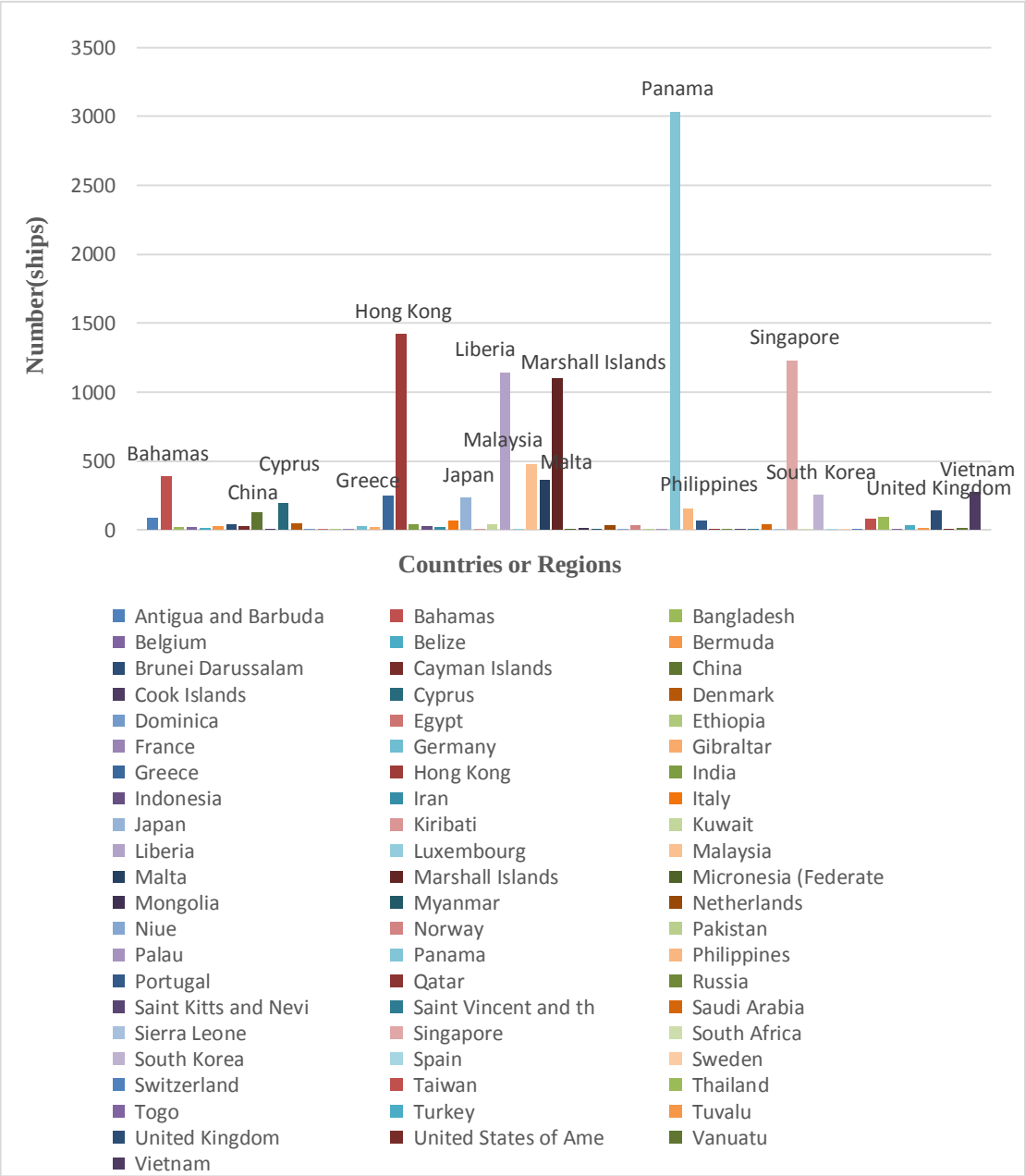

Fig 3-9 Registry distribution in March 2017

As seen from Figure 3-9, out of the 64 registry countries or areas of the vessels sailing in the South China Sea in March 2017, Panama ranks the top and Hong Kong (China) the second.

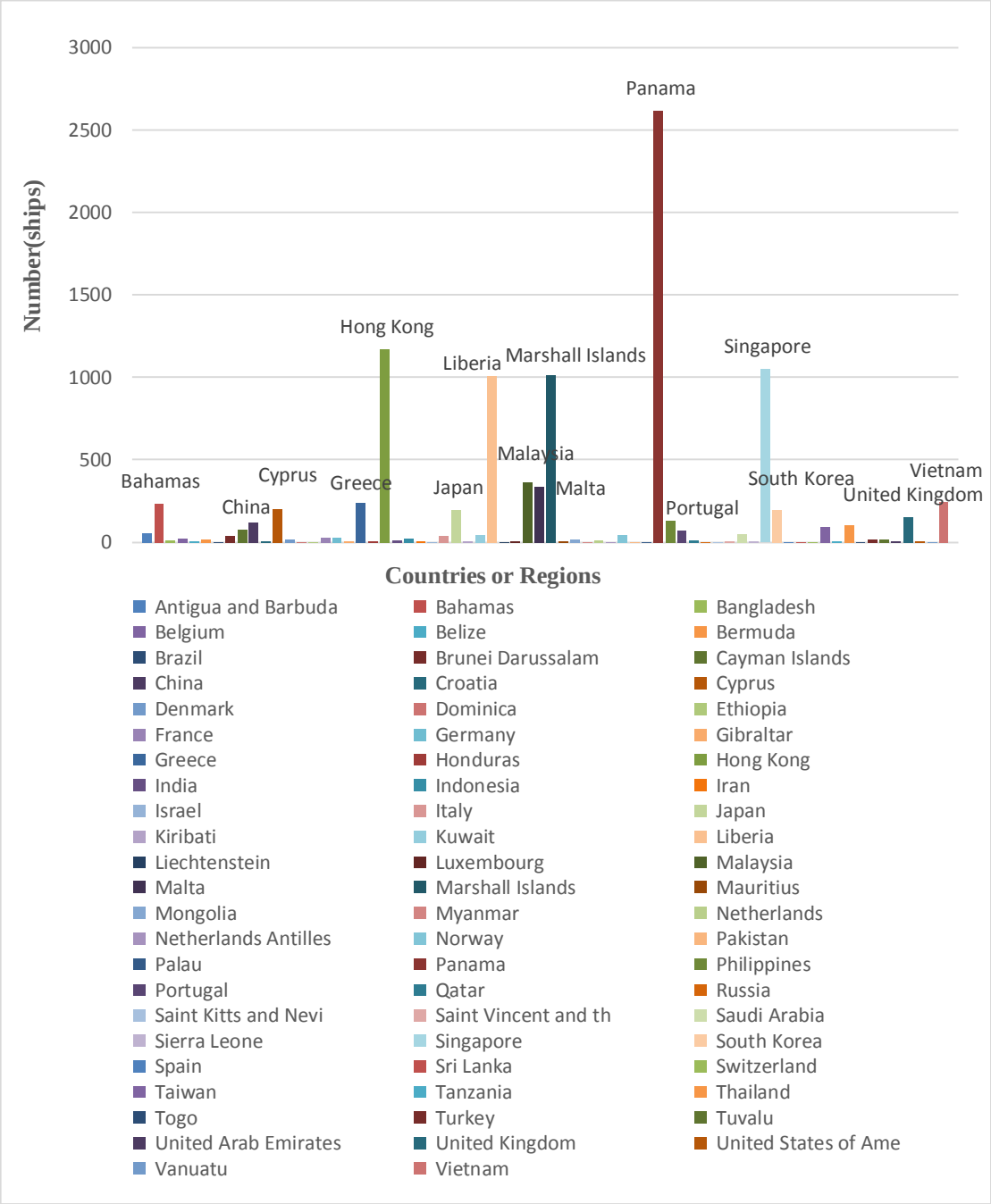

Fig 3-10 Registry distribution in June 2017

As seen from Figure 3-10, out of the 68 registry countries or areas of the vessels sailing in the South China Sea in June 2017, Panama ranks the top followed by Hong Kong (China) and Marshall Islands.

2) Total capacity statistics of the top 50 national/regional fleets

The South China Sea vessel traffic flow trends, navigation activities and their distribution can be further clarified by comparing the AIS and registry statistics (of the time March and June, 2017) with the same time national/regional total fleet capacity statistics (the top 50 fleets) provided by Clarkson SIN (Clarkson Shipping Intelligence

Network). Results are shown in Table 3-5and Table 3-6.

Table 3-5National/regional top 50 fleet total capacity statistics in the world (March 2017) (from Clarkson SIN)

Rank	Country or region	No. of ships	Gross deadweight /tons	Rank	Country or region	No. of ships	Gross Deadweight /tons	Rank	Country or region	No. of ships	Gross deadweight /tons
1	Greece	2609	252475018	64	Malta	88	846122	127	Fiji	42	12322
2	Japan	3300	220718195	65	Syria	93	815987	128	Senegal	16	11010
3	China P.R.	3425	194161699	66	Bahamas	43	781789	129	Cape Verde	20	10491
4	Germany	1414	86597361	67	Luxembourg	10	766081	130	Anguilla	5	10487
5	South Korea	2170	82036378	68	Peru	96	701079	131	Gabon	26	10357
6	Norway	2062	74915362	69	Panama	193	647476	132	Samoa	9	10314
7	Taiwan, China	1076	56390871	70	Estonia	147	632337	133	Haiti	8	10147
8	United States	2580	55423235	71	Yemen	48	587966	134	Guernsey	3	9865
9	Singapore	2107	52174582	72	Cuba	83	574412	135	Mauritania	3	9135
10	Italy	1561	50648816	73	Ecuador	114	561081	136	Cook Islands	4	9125
11	Hong Kong China	866	38689325	74	North Korea	137	556272	137	Madagascar	25	7974
12	Canada	917	36259139	75	Iraq	99	552279	138	Equatorial Guinea	12	6724
13	Belgium	439	24903743	76	Marshall Is.	62	520726	139	Neth. Antilles	1	6384
14	France	780	22521939	77	Kazakhstan	86	408718	140	Dominican Rep	34	6043
15	Russia	1108	19769642	78	Cameroon	14	363539	141	Sao Tome	1	5586
16	India	1042	19216970	79	Brunei	93	360744	142	Djibouti	14	5115
17	United Kingdom	1042	19216970	80	Ethiopia	11	335796	143	Vanuatu	4	4881
18	Saudi Arabia	573	18969502	81	Tunisia	58	308895	144	Nicaragua	6	4764
19	Turkey	929	18569113	82	Sri Lanka	77	273958	145	Puerto Rico	35	4714
20	Malaysia	1065	18482906	83	Latvia	79	234236	146	Antigua & B.	4	4580
21	Iran	476	18466558	84	Jordan	47	232311	147	Somalia	6	4506
22	Netherlands	1724	16544646	85	Lithuania	90	228383	148	Papua N. Guinea	10	4316
23	Denmark	1724	16544646	86	Liberia	34	209202	149	Gambia	9	4309
24	Bermuda	80	12322211	87	Seychelles	29	208799	150	Grenada	13	4014
25	Brazil	623	12312438	88	Iceland	49	181449	151	New Caledonia	14	3810
26	Indonesia	2589	11308724	89	Papua N. Guinea	141	163816	152	Micronesia	6	3504
27	Switzerland	252	10226627	90	Myanmar	91	158054	153	Cambodia	2	3373
28	U.A.E.	950	8949376	91	Bahrain	122	156495	154	Congo	13	3332
29	Oman	75	7796066	92	Colombia	131	152589	155	Madeira	4	3221
30	Sweden	436	7200981	93	Mauritius	19	147987	156	Solomon	15	2942

Rank	Country or region	No. of ships	Gross deadweight /tons	Rank	Country or region	No. of ships	Gross Deadweight /tons	Rank	Country or region	No. of ships	Gross deadweight /tons
31	Kuwait	197	7121070	94	Montenegro	13	140880	157	Curacao	15	2862
32	Thailand	586	6935107	95	Austria	6	132060	158	Bolivia	4	2663
33	Monaco	80	6502003	96	St. Kitts & Nevis	15	127131	159	Guadeloupe	25	2298
34	Vietnam	658	6352779	97	Albania	69	108348	160	Liechtenstein	3	2203
35	Thailand	218	6259068	98	Maldives Is.	52	105960	161	Jamaica	14	2164
36	Australia	362	6196592	99	Tanzania	50	96580	162	Tonga	6	2076
37	Qatar	173	5180458	100	Faroe Islands	49	87543	163	Martinique	6	2072
38	Israel	159	4179018	101	Morocco	78	86874	164	Kiribati	3	1973
39	Egypt	464	3714355	102	Turkmenistan	39	81352	165	Saint Lucia	1	1821
40	Egypt	88	3312897	103	Greenland	19	80044	166	Benin	6	1716
41	Spain	541	3262840	104	Uruguay	60	58195	167	Turks & Caicos Is	3	1615
42	Poland	247	2940699	105	New Zealand	104	56661	168	Laos	1	1562
43	Croatia	247	2940699	106	Honduras	61	54021	169	Macao China	4	1521
44	Brazil	319	2910607	107	Kenya	48	51064	170	Ivory Coast	21	1348
45	Bangladesh	262	2685641	108	Guyana	57	50980	171	Mayotte	6	1244
46	Libya	102	2570203	109	Paraguay	41	41947	172	Bonaire Island	1	1103
47	Finland	209	2275846	110	Belize	26	37823	173	Saint Pierre	2	1054
48	Ireland	184	2042413	111	Trinidad	108	32367	174	American Samoa	5	1036
49	Ukraine	448	1959646	112	Guatemala	10	30221	175	N. Mariana Island	4	980
50	Mexico	448	1959646	113	French Poly.	48	29382	176	Togo	7	943
51	Venezuela	230	1926022	114	Gibraltar	15	28653	177	Aruba	3	938
52	Pakistan	69	1870067	115	Ghana	46	28104	178	Guam	9	834
53	Bulgaria	141	1853537	116	Mozambique	27	22380	179	Tuvalu	1	578
54	Nigeria	351	1847710	117	Cayman Islands	11	21824	180	Malvinas Islands	2	541
55	Azerbaijan	318	1647997	118	Canary Islands	14	21458	181	Timor-Leste	2	532
56	Lebanon	171	1566493	119	Georgia	48	18886	182	Tokelau	1	446
57	Philippines	705	1340738	120	Congo	14	17093	183	Reunion	3	213
58	South Africa	142	1284948	121	Slovenia	10	15676	184	Moldova	1	212
59	Portugal	133	1207785	122	Sierra Leone	20	13873	185	Namibia	3	183
60	Algeria	127	1199590	123	Sudan	21	13865	186	Dominica	1	155
61	Isle Of Man	39	983295	124	Eritrea	9	13841	187	Costa Rica	2	129
62	Romania	181	903895	125	Suriname	12	13110	188	Salvador	3	62
63	Argentina	166	868364	126	St. Vincent & G.	10	12443	189	Barbados	1	60

Table 3-6National/regional top 50 fleet total capacity statistics in the world (June 2017)
(from Clarkson SIN)

Rank	Country or region	No. of ships	Gross deadweight /tons	Rank	Country or region	No. of ships	Gross Deadweight /tons	Rank	Country or region	No. of ships	Gross deadweight /tons
1	Greece	2609	252475018	64	Malta	88	846122	127	Fiji	42	12322
2	Japan	3300	220718195	65	Syria	93	815987	128	Senegal	16	11010
3	China P.R.	3425	194161699	66	Bahamas	43	781789	129	Cape Verde	20	10491
4	Germany	1414	86597361	67	Luxembourg	10	766081	130	Anguilla	5	10487
5	South Korea	2170	82036378	68	Peru	96	701079	131	Gabon	26	10357
6	Norway	2062	74915362	69	Panama	193	647476	132	Samoa	9	10314
7	Taiwan, China	1076	56390871	70	Estonia	147	632337	133	Haiti	8	10147
8	United States	2580	55423235	71	Yemen	48	587966	134	Guernsey	3	9865
9	Singapore	2107	52174582	72	Cuba	83	574412	135	Mauritania	3	9135
10	Italy	1561	50648816	73	Ecuador	114	561081	136	Cook Islands	4	9125
11	Hon Kong China	866	38689325	74	North Korea	137	556272	137	Madagascar	25	7974
12	Canada	917	36259139	75	Iraq	99	552279	138	Equatorial Guinea	12	6724
13	Belgium	439	24903743	76	Marshall Is.	62	520726	139	Neth. Antilles	1	6384
14	France	780	22521939	77	Kazakhstan	86	408718	140	Dominican Rep	34	6043
15	Russia	1108	19769642	78	Cameroon	14	363539	141	Sao Tome	1	5586
16	India	1042	19216970	79	Brunei	93	360744	142	Djibouti	14	5115
17	United Kingdom	1042	19216970	80	Ethiopia	11	335796	143	Vanuatu	4	4881
18	Saudi Arabia	573	18969502	81	Tunisia	58	308895	144	Nicaragua	6	4764
19	Turkey	929	18569113	82	Sri Lanka	77	273958	145	Puerto Rico	35	4714
20	Malaysia	1065	18482906	83	Latvia	79	234236	146	Antigua &B.	4	4580
21	Iran	476	18466558	84	Jordan	47	232311	147	Somalia	6	4506
22	Netherlands	1724	16544646	85	Lithuania	90	228383	148	Papua N. Guinea	10	4316
23	Denmark	1724	16544646	86	Liberia	34	209202	149	Gambia	9	4309
24	Bermuda	80	12322211	87	Seychelles	29	208799	150	Grenada	13	4014
25	Brazil	623	12312438	88	Iceland	49	181449	151	New Caledonia	14	3810
26	Indonesia	2589	11308724	89	Papua N. Guinea	141	163816	152	Micronesia	6	3504
27	Switzerland	252	10226627	90	Myanmar	91	158054	153	Cambodia	2	3373
28	U.A.E.	950	8949376	91	Bahrain	122	156495	154	Congo	13	3332
29	Oman	75	7796066	92	Colombia	131	152589	155	Madeira	4	3221
30	Sweden	436	7200981	93	Mauritius	19	147987	156	Solomon	15	2942
31	Kuwait	197	7121070	94	Montenegro	13	140880	157	Curacao	15	2862
32	Thailand	586	6935107	95	Austria	6	132060	158	Bolivia	4	2663
33	Monaco	80	6502003	96	St. Kitts & Nevis	15	127131	159	Guadeloupe	25	2298
34	Vietnam	658	6352779	97	Albania	69	108348	160	Liechtenstein	3	2203
35	Thailand	218	6259068	98	Maldives Is.	52	105960	161	Jamaica	14	2164
36	Australia	362	6196592	99	Tanzania	50	96580	162	Tonga	6	2076
37	Qatar	173	5180458	100	Faroe Islands	49	87543	163	Martinique	6	2072
38	Israel	159	4179018	101	Morocco	78	86874	164	Kiribati	3	1973

Rank	Country or region	No. of ships	Gross deadweight /tons	Rank	Country or region	No. of ships	Gross Deadweight /tons	Rank	Country or region	No. of ships	Gross deadweight /tons
39	Egypt	464	3714355	102	Turkmenistan	39	81352	165	Saint Lucia	1	1821
40	Egypt	88	3312897	103	Greenland	19	80044	166	Benin	6	1716
41	Spain	541	3262840	104	Uruguay	60	58195	167	Turks & Caicos Is	3	1615
42	Poland	247	2940699	105	New Zealand	104	56661	168	Laos	1	1562
43	Croatia	247	2940699	106	Honduras	61	54021	169	Macao China	4	1521
44	Chile	319	2910607	107	Kenya	48	51064	170	Ivory Coast	21	1348
45	Bangladesh	262	2685641	108	Guyana	57	50980	171	Mayotte	6	1244
46	Libya	102	2570203	109	Paraguay	41	41947	172	Bonaire Island	1	1103
47	Finland	209	2275846	110	Belize	26	37823	173	Saint Pierre	2	1054
48	Ireland	184	2042413	111	Trinidad	108	32367	174	American Samoa	5	1036
49	Ukraine	448	1959646	112	Guatemala	10	30221	175	N. Mariana Island	4	980
50	Mexico	448	1959646	113	French Poly.	48	29382	176	Togo	7	943
51	Venezuela	230	1926022	114	Gibraltar	15	28653	177	Aruba	3	938
52	Pakistan	69	1870067	115	加纳	46	28104	178	Guam	9	834
53	Bulgaria	141	1853537	116	Mozambique	27	22380	179	Tuvalu	1	578
54	Nigeria	351	1847710	117	Cayman Islands	11	21824	180	Malvinas Islands	2	541
55	Azerbaijan	318	1647997	118	Canary Islands	14	21458	181	Timor-Leste	2	532
56	Lebanon	171	1566493	119	Georgia	48	18886	182	Tokelau	1	446
57	Philippines	705	1340738	120	Congo	14	17093	183	Reunion	3	213
58	South Africa	142	1284948	121	Slovenia	10	15676	184	Moldova	1	212
59	Portugal	133	1207785	122	Sierra Leone	20	13873	185	Namibia	3	183
60	Algeria	127	1199590	123	Sudan	21	13865	186	Dominica	1	155
61	Isle Of Man	39	983295	124	Eritrea	9	13841	187	Costa Rica	2	129
62	Romania	181	903895	125	Suriname	12	13110	188	Salvador	3	62
63	Argentina	166	868364	126	St. Vincent & G.	10	12443	189	Barbados	1	60

Table 3-5 and Table 3-6 show the ranks of 189 countries or regions in the world in terms of the overall tonnage of their top 50 fleet total capacities, those with ships in the South China Sea during March and June, 2017 being highlighted. It can be concluded that among the top 100 countries or regions, especially the top 35, the vast majority have vessels in the South China Sea. Flag states with their vessels in the South China Sea spread all over the world, including the top 35 and the last 35 countries or regions in terms of the fleet capacity. The freedom and convenience of navigation in the South China Sea waters is enjoyed by all states.

3) Comparison and contrast between the AIS statistics and the world total fleet capacities

The proportions of the ship number in the South China Sea (as shown in Table

3-4) to that of the total world (countries and regions, as shown in Table 3-7) are 15% (7907/52886) in March 2017 and 14.2% (7512/52886) in June 2017. However, considering the relevance of the commerce and trade value to ships' size/tonnage, these data cannot represent the actual and consistent fleet activities of a country or region in the South China Sea. In view of this, this research takes the measurement of capacity mapping to show the shipping activities of a country or region.

Capacity mapping refers to the comparison and contrast between the total transport capacity (ship number and tonnage) of countries and regions with ships and vessels passing the South China Sea and that of the world 189 countries and regions (in terms of their respective top 50 fleets). In this way, it can be shown with validity and consistency the ship transport capacity allocation, capability and possibility (randomness) of the countries and regions with ships and vessels passing the South China Sea.

(1) Table 3-5 and Table 3-6 show the ranks of the 189 countries or regions in the world in terms of their total capacities.

(2) The benchmarking analyses of Figure 3-9, Figure3-10 and Table 3-5, Table 3-6 get proportions of the total ship transport capacity of countries and regions with ships passing the South China Sea to that of all the 189 countries and regions (in terms of the overall tonnage of their respective top 50 fleets) in the world, which prove the freedom of navigation in the South China Sea is enjoyed by merchant ships from all countries and regions in the world (as is shown in Table 3-7 and Table 3-8).

Table 3-7 Proportions of the fleet capacity in the South China Sea to that of the world (March 2017, Clarkson SIN)

Waters and total capacity mapping	No. of vessels	GT (ton)
the South China Sea	42329	1470604352
World	52886	1598250766
Proportion	80.04%	92.01%

Table 3-8 Proportions of the fleet capacity in the South China Sea to that of the world (June 2017, Clarkson SIN)

Waters and total capacity mapping	No. of vessels	GT (ton)
the South China Sea	43642	1488644939
World	52886	1598250766
Proportion	82.52%	93.14%

3.5 The South China Sea AIS Data Validity

1) Resource and data source control

Data resources and sources in this South China Sea shipping status study include: (1) Professional navigation publications by the Chinese and the British Admiralty authorities; (2) Resources about the navigation guarantee in the South China Sea

provided by authorities at home and abroad; (3) The satellite AIS data of ships and vessels in the South China Sea from Exact Earth; (4) National/regional top 50 fleet total capacity statistics provided by the Clarkson Shipping Intelligence.

2) The satellite AIS data validity analysis and control

Concerning the non-real-time communication nature of the satellite AIS data, the following points are noted:

(1) There are renewal intervals and ship inspection delays in the satellite AIS data collection;

(2) There are flying-over intervals and communication delays of the satellite AIS;

(3) The convergence of the ship AIS signals, when the satellite flies over an area with a high ship traffic density, will result in the significant decrease of successful AIS signal reception. Therefore, there will be data blind spots in some parts due to the fact that the dense ship traffic flow in the South China Sea may lead to the satellite signal loss.

(4) There exist some ships and vessels without AIS or off signal

Bearing the above points in mind, this research takes the basic observation planes as the axes, extending the planes into bands (areas) so that the signals from the ships nearby the observation planes can be retrieved. In this way, data collection and mining can be greatly improved.

Results from the data analysis are as follow. Data shows the consistency between March 2016 and the same month of 2017; a decrease by 20% in June 2017 compared with June 2016. The reason for the decrease of ships in the South China Sea in June 2017 lies in the fact that the tropical cyclone didn't happen in June 2016 but happened once during 12^{th}-16^{th}, June 2017. In general there is not significant change of ship traffic flow in the South China Sea between 2016 and 2017.

Chapter 4 Traffic Safety and Securities in the South China Sea

4.1 Traffic Safety and Securities Profile in the South China Sea

Traffic safety and securities in the South China Sea involve disastrous weather, marine accidents, external security incidents, route and navigation safety and navigation guarantee conditions.

Owing to the rapid developments of maritime technologies, of larger-scale and higher-speed vessels and to seafarers' improved integrative competence, disastrous weather (such as tropical cyclone transit) prevention capabilities of ships and vessels have been fully guaranteed, thus very low probability of marine accidents in these waters. However, there is need for further strengthening and coordination between fishing ships and merchant ships in the South China Sea in terms of their cooperation and security relationship.

In recent years, there occasionally happen security incidents (such as pirate attack and armed ship robbery) in the peripheral areas of the South China Sea, but not within the core areas. There is the rise of security incidents in 2017, by 19% compared with those in 2016. The year 2017 witnessed totally 101 incidents of pirate attack and armed ship robbery in the Southwest Asia waters, 12 of which were attempted ones. In the year of 2017, 22 incidents happened in the waters near Manila, Philippines, 33 incidents near Indonesia, thus high-risk places; a total of 12 incidents with one attempted happened (for ships underway) in the waters near Singapore and the Malaysia Peninsula.

Moreover, the navigation guarantee has been developed especially in the northern part of the South China Sea. China coast-line areas have been equipped with advanced Vessel Traffic Services (VTS). Further work is to be done in the central and the south areas of the South China Sea. There has been conducted practical cooperation between China and ASEAN countries in maritime search and rescue in the South China Sea.

4.2 Free Choosing Routes in the South China Sea

In light of the "safety and economy" fundamental principle of sea route choosing, merchant ships and vessels have the options of recommended routes such as the east routes (Palawan), the middle (Main) routes and the west routes in accordance with vessel tonnage/power and with monsoons. Sea routes are distributed away from islands and reefs (with the average distance of more than 10 nautical miles). The vessel traffic flow in the China coastal waters only represents the percentage of 2.5% of the total in the South China Sea. That is, the vessel traffic flow near islands and reefs is very small; the majority (97.5%) sails through the open areas of the South China Sea. Moreover, island and reef constructions in the South China Sea, especially those of Nansha Qundao (the Nansha Islands) are far away from sea routes. Satellite

AIS data analyses of the ship traffic flow in the South China Sea show recommended sea routes are regularly chosen by the passing ships and vessels. It can be concluded that sea routes in the South China Sea as well as the navigation near islands and reefs are freely chosen by merchant ships and vessels.

4.3 Safe and Secure Traffic in the South China Sea

Safety is out of aids and service involving navigation and risk prevention, weather prognostics and bulletins, marine salvage, the essence of which is facility allocation and construction, regulation implementation and management.

Presently, merchant ships and vessels can receive position reports day and night with GPS, DGPS and the Beidou Satellite Navigation System covering the complete areas of the South China Sea. Five large-scale multifunction light houses (shown in Figure 2-2) with the light range of more than 20 nautical miles constructed by the Chinese Government on such sites as the Huayang Reef, Nansha Qundao (the Nansha Islands) provide navigation and risk prevention services for the passing ships and vessels of the middle routes.

The signal coverage of Xisha Qundao (the Xisha Islands) major waters has been completed by the Chinese Government with four light beacons on such islands as the Jinqing Island (Drummond Island) and with four automatic identification base stations on such islands as Yongxing Dao (the Yongxing Island). The signal coverage of Xisha Qundao (theXisha Islands) waters and of Zhongsha Qundao (the Zhongsha Islands) waters has been realized with the broadcast service of safety message at sea (including radio navigational warnings) and with the weather prognostics.

In accordance with the provision that IMO member states shall provide the service of maritime search and rescue, China Ship Reporting System (CHISREP) is in operation with stations receiving ship reports via satellites and radios and sending them to China Ship Reporting Management Centre. Aids and services are accessible all the time with the rescue bases set up by the Nanhai Rescue Bureau of the Ministry of Transport of PRC (NRB) in the cities of Haikou, Sanya, Xisha, Guangzhou, Yangjiang, Shenzhen, Zhanjiang, Shantou and Beihai, watchkeeping ships being deployed on stand-by in sea areas concerned. In conclusion, the traffic in the South China Sea is safe and secure.

Chapter 5 Conclusions

Findings from the quantitative and qualitative analyses of the Satellite AIS statistics of ship traffic flow in the South China Sea and from the integrated analyses of sea routes, safety and security aids and services are as follow. In the South China Sea, the recommended routes are regularly and freely chosen by the large traffic flow of passing merchant ships and vessels with relatively big length, breadth, draft and with the average stable speed; the passing vessels with their registry ports covering about 70 (64-68) major shipping countries and districts in the world represent more than 92% world capacities of 189 nations and regions (in terms of the overall tonnage of their respective top 50 fleets); the light houses and other public interest service facilities constructed on islands and reefs are effectively safeguarding and serving the navigation in the South China Sea.

In conclusion, the traffic in the South China Sea is unhindered and safe with the scientifically-distributed and freely-chosen sea routes, specifically:

- The quantitative analyses of the Satellite AIS statistics show merchant ships and vessels of different nations or regions navigate in the South China Sea safely and smoothly with the stable speed;
- Free and safe navigation in the South China Sea is accessible for merchant fleets of different nations or regions worldwide with China's regular cruising and continuous management safeguarding the very area.
- With the recommended routes for merchant ships and vessels far away from islands and reefs, the freedom of navigation is enjoyed by merchant ships and vessels. Considering the intersecting sea routes, the navigation guarantee and service in the South China Sea needs to be further strengthened.
- Public interest service facilities in the South China Sea, including light houses, light beacons, automatic identification system base stations and so on, have continuously provide the technological support for the safe and secure navigation, the maintenance of which by China needs to be further strengthened and represents the implementation of the international responsibilities and obligations on the part of China as an IMO member state.
- China, through providing the effective navigation guarantee in the South China Sea waters, has continuously committed to the effective implementation of responsibilities and obligations as a coastal state of international navigable waters and as an IMO member state. China depicts the future of the South China Sea as with peace, friendship and cooperation based on the joint implementation of relevant international laws and conventions with countries in this area.

References

1. Publications

[1] Admiralty List of Radio Signals NP281 (2). 2016/17.

[2] Admiralty Sailing Directions NP44（2013）—Malacca Strait and the West Coast of Sumatera Pilot.

[3] Admiralty Sailing Directions NP32（2013）—China Sea Pilot Volume 3.

[4] Admiralty Sailing Directions NP31（2013）—China Sea Pilot Volume 2.

[5] Admiralty Sailing Directions NP30（2013）—China Sea Pilot Volume 1.

[6] Tide Tables（Nanhai Waters, Chinese edition）H103(2017).

[7] Admiralty Ocean Passages for the World NP136(2014).

[8] National Maritime Search and Rescue Manual (current edition). Dalian, China: Dalian Maritime University Press.

[9]International Convention for the Safety of Life at Sea (SOLAS), Consolidated Edition, 2014 Edition (IMO Sales No.: IF110E).

[10]International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention), as amended, STCW inc.2010 Manila Amendments, 2011 Edition (IMO Sales No.: IC938E).

[11] Chinese Sailing Direction (Nanhai Waters) A103(2016). China Navy Hydrographic Office.

[12] Navigation Guide for Ports along the Guangdong Coast (2013). China Maritime Safety Administration.

[13] Navigation Guide for Hainan Island Waters (2007). China Maritime Safety Administration.

2. Charts

[1] Catalogue of Nautical Publications K102 (2017). China Navy Hydrographic Office.

[2] Admiralty Maritime Product & Service Catalogue (2017).

[3] Nautical Charts (paper and electronic editions), the South China Sea to Singapore.

3. Others

[1] Satellite AIS Data Source：Exact Earth, Canada Limited (HiFleet Agency, China).

[2]Clarkson Shipping Intelligence Network（Clarkson SIN）(http://www. Clarksons.net).

[3] ANNUAL（JANUARY - DECEMBER 2017）REPORT PIRACY AND

ARMED ROBBERY AGAINST SHIPS IN ASIA，ReCAAP Information Sharing Centre (ISC). ReCAAP: Regional Cooperation Agreement on Combating Piracy and Armed Robbery against Ships in Asia

[4] WANG, Jing, QIAN Chuan-hai and ZHANG Ling. (2018). The characteristics and impact of typhoon activities over western North Pacific and the South China Sea. *Journal of Marine Meteorology*, 38(2): 1-11.