



**UNITED NATIONS ENVIRONMENT PROGRAMME**



**EAST ASIAN SEAS REGIONAL COORDINATING UNIT**

**UNEP**

**UNEP/GEF  
Project Coordinating Unit**

# **NATIONAL REPORT OF CHINA**

**on the**

**Formulation of a Transboundary Diagnostic Analysis  
and**

**Preliminary Framework of a Strategic  
Action Programme for the South China Sea**





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## PREFACE

The 12<sup>th</sup> National Focus Point Conference was held by UNEP in 1996 at Bangkok Thailand to discuss the 'Regional Program of Action for Protecting and Developing the Marine and Coastal Environment of the East Asian Seas' (the East Asian Seas Action Plan). The East Asian Seas Action Plan is an important component part for the implementation of the 21st Century Agenda and the Global Program of Action for the Protection of the Marine Environment from Land-based Activities.

The formulation of the project recommendations for a Transboundary Diagnostic Analysis and Preliminary Framework of a Strategic Action Program for the South China Sea was adopted by the 12th Conference of the Coordinating Body on the Seas of East Asia and the project will be financed by the GEF.

The objectives of the regional project recommendations are:

- To make a transboundary diagnostic analysis on the main environmental problems and their causes;
- To identify all types of land-based sources of pollution along the coast of periphery states;
- To indicate the modification of the living aquatic resources;
- To identify the pollution hot spots and sensitive areas; and
- To determine the priority and the management goals.

On the basis of above actions the preliminary framework of a strategic action program will be formulated to protect the South China Sea from pollution of land-based activities.

The regional project recommendations will be based on the 7 national reports of the member states. This national report of China, about the transboundary diagnostic analysis and strategic action program for the South China Sea in China part and as a component of the regional project recommendations, has been written according to the Secretariat's demand of the Coordinating Body on the Seas of East Asia.

## **1. INTRODUCTION**

### **1.1 Aim of China National Report**

The national report of China is compiled in accordance with requirements by the secretariat of the coordinating body on the Seas of East Asia. It is aimed through this report to provide data and information on major water-related environmental problems/issues in South China Sea and its associated watershed areas in China part, and to provide causal analysis of the problems.

### **1.2 Major Water-related Environment Problems**

Under the pressure of both rapid economic development and large population in the South China Sea associated watershed areas, the environment in China part has the problems as below:

- The catch amount of both fish and other living aquatic resources in rivers and coastal waters of the sea decrease year by year. The percentage of precious and high value species of living aquatic resources in rivers and shallow marine waters decrease due to over exploitation of living aquatic resources.
- Near-shore seawaters in part of estuaries and bays and by big cities are polluted and the major pollutants are nutrients (N &P) and oil although as a whole, seawater quality maintains good level. Red tide occurs frequently in inner bays and estuaries in past years due to nutrients coming from domestic wastewater and industry wastewater discharge, rivers and marine aquaculture.
- Organic and nutrient pollutants pollute freshwater in most rivers. Freshwater pollution is serious in the down stream of such bigger rivers as the Pearl River which is the biggest river in south China empty to the South China Sea, Han River, Rong River, Moyang River, and Jian River in Guangdong Province, and Nandu River in Hainan Province.
- River water quality deterioration causes freshwater shortage. In Pearl River Delta, freshwater pollution in several river courses at cities is so serious that the water quality is not suitable for drinking water resource although these cities are rich in freshwater.
- Aquatic habitats in rivers, estuaries and coastal waters have changed significantly. In past years, mangrove area and both coastal wetland area and inland wetland area decreased due to inappropriate coastal and wetland development.

### **1.3 Country Background**

China is a big country with 9.6 million square kilometers of territorial land including many islands. Total area of the Bohai Sea, the Yellow Sea, the East China Sea and the South China Sea is more than 4.7 million square kilometers. China also has a large population more than 1.2 billion.

China coastal areas of the South China Sea, including Guangdong Province, Hong Kong, Macau, Guangxi Zhuang Nationality Autonomous Region and Hainan Province, are relatively developed and densely populated areas in China. There are three metropolises with population more than one million (Hong Kong, Guangzhou and Shenzhen) and many medium-sized and small-sized cities located in the coastal zone of the South China Sea. The coastal zone, with favorable weather and economic geographical conditions, is the most rapidly developing area in China in the past years. It is expected that this area will keep quick development in coming years. Demography data of coastal cities and counties is listed in Table 1.1.

**Table 1.1 Demography of the SCS coastal cities and counties**

| Region                          | Total population | Average annual population growth (%)        | Average annual birth rate (%) | Average annual death rate (%) | Average annual migration rate |
|---------------------------------|------------------|---|-------------------------------|-------------------------------|-------------------------------|
| <b>Guangdong Province(1996)</b> |                  | <b>Provincial average from 1991 to 1996</b> |                               |                               |                               |
| Chaozhou City                   | 2,338,040        |   |                               |                               |                               |
| Shantou City                    | 4,072,900        |   |                               |                               |                               |
| Jieyang City                    | 4,919,360        |   |                               |                               |                               |
| Shanwei City                    | 2,520,330        |   |                               |                               |                               |
| Huizhou City                    | 2,600,810        |   |                               |                               |                               |
| Shenzhen City                   | 1,033,840        |   |                               |                               |                               |
| Dongguan City                   | 1,452,460        |   |                               |                               |                               |
| Guangzhou City                  | 6,560,510        |   |                               |                               |                               |
| Zhongshan City                  | 1,268,430        |   |                               |                               |                               |
| Zhuhai City                     | 653,660          |   |                               |                               |                               |
| Jiangmen City                   | 3,743,620        |   |                               |                               |                               |
| Yangjiang City                  | 2,425,140        |   |                               |                               |                               |
| Maoming City                    | 5,813,570        |   |                               |                               |                               |
| Zhanjiang City                  | 6,160,160        |   |                               |                               |                               |
| Subtotal                        | 48,562,830       | 16.36                                       | 18.76                         | 5.92                          | 3.53                          |
| <b>Guangxi Region(1996)</b>     |                  | <b>Average from 1995 to 1996</b>            |                               |                               |                               |
| Beihai City                     | 1,354,200        | 12.11                                       | 11.22                         | 4.07                          | 4.95                          |
| Qingzhou City                   | 3,046,300        | 11.74                                       | 14.89                         | 5.24                          | 2.09                          |
| Fangcheng Port C.               | 747,800          | 14.90                                       | 13.27                         | 4.76                          | 6.41                          |
| Subtotal                        | 5,148,300        | 12.92                                       | 13.13                         | 4.69                          | 4.48                          |
| <b>Hainan province (1996)</b>   |                  | <b>Average from 1991 to 1996</b>            |                               |                               |                               |
| Haikou City                     | 499,350          |   |                               |                               |                               |
| Qionghai City                   | 633,050          |   |                               |                               |                               |
| Wenchang City                   | 521,300          |   |                               |                               |                               |
| Qionghai City                   | 435,950          |   |                               |                               |                               |
| Wanning City                    | 532,190          |   |                               |                               |                               |
| Lingshui City                   | 307,650          |   |                               |                               |                               |
| Sanya City                      | 420,980          |   |                               |                               |                               |
| Ledong County                   | 453,860          |   |                               |                               |                               |
| Dongfang City                   | 341,640          |   |                               |                               |                               |
| Changjiang County               | 219,040          |   |                               |                               |                               |
| Danzhou City                    | 783,210          |   |                               |                               |                               |
| Lingao County                   | 382,400          |   |                               |                               |                               |
| Chengmai County                 | 444,110          |   |                               |                               |                               |
| Other Islands                   | 243              |   |                               |                               |                               |
| Subtotal                        | 5,982,880        | 15.50                                       | 21.06                         | 5.85                          | 0.66                          |
|                                 |                  | <b>Average from 1991 to 1995</b>            |                               |                               |                               |
| Hong Kong (1995)                | 6,156,000        | 1.71  | 11.88                         | 5.12                          | -4.99                         |
| Macau (1995)                    | 424,430          | 3.93  | 16.56                         | 3.64                          | -8.32                         |



#### 1.4 Geographic Divisions Used in the Analysis

The area of the South China Sea (SCS) is about 3.5 million square kilometers, a width of 1667 kilometers from west to east and a length of 2693 kilometers from north(23°40'N) to south(18°09'N). The average depth of the SCS is 1212 meters. Also see Figure 1.1- Geographical Position of the South China Sea and Figure 1.2 – China’s Boundaries of SCS. China has 6,888 kilometers of coastline along the SCS including 403 kilometers coastline in Hong Kong and Macau) from Raoping County at Guangdong Province to Beilun estuary of Guangxi Zhuang Autonomous Region. There are five administrative regions located along coast of and in the SCS: Guangdong Province, Hong Kong Special Administrative Region, Macau, Guangxi Zhuang Autonomous Region and Hainan Province.

Because a major part of concerned statistic data is totaled up from counties to cities, then from cities to provinces or autonomous, and finally to nation, the coastal area of the South China Sea in China part is divided into five subregions in the analysis. They are Guangdong, Hong Kong, Macau, Guangxi and Hainan. Major rivers in each subregion are seen in Table 1.2 and Figure 1.4 – River Basins in South China.

**Table 1.2 Geographic divisions used in the analysis**

| Subregion | Major City   | Name of major rivers           | Total area (km <sup>2</sup> ) | Total population (1995) |
|-----------|--|--------------------------------|-------------------------------|-------------------------|
| Guangdong | Chaozhou, Shantou, Jieyang, Shanwei, Huizhou, Shenzhen, Dongguan, Guangzhou, Zhongshan, Zhuhai, Jiangmen, Yangjiang, Maoming and Zhanjiang | Han, Rong, Pearl, Moyang, Jian | 83,332.8                      | 47,918,660              |
| Guangxi   | Beihai, Qingzhou and Fangcheng Port  | Nanliu, Qing, Maoling          | 20,361                        | 5,088,000               |
| Hainan    | Haikou and Sanya   | Nandu, Changhua, Wanquanhe     | 33,920                        | 5,733,100               |
| Hong Kong | Hong Kong  | No                             | 1,068                         | 6,190,000               |
| Macau     | Macau  | No                             | 21.45                         | 424,430                 |
| Total     | 21   | 11                             | 104,783.25                    | 65,354,210              |

##### *Guangdong subregion*

There are fourteen coastal cities and many offshore islands including Dongsha Islands. Fourteen coastal cities from east to west in Guangdong subregion are: Chaozhou City, Shantou City, Jieyang City, Shanwei City, Huizhou City, Shenzhen City, Dongguan City, Guangzhou City, Zhongshan City, Zhuhai City, Jiangmen City, Yangjiang City, Maoming City and Zhanjiang City. Guangzhou City and Shenzhen City are metropolises. There are five major rivers and 66 small rivers directly discharged to the South China Sea. Six geographic subdivisions in Guangdong subregion are:

- Chaozhou City, Shantou City and Jieyang City are located in Han River basin and Rong River basin at the east of Guangdong subregion. Han River and Rong River empty to the SCS at Shantou City;
- Shanwei City and Huidong County in Huizhou City in the middle east of Guangdong subregion. There are tens of small rivers flow to the SCS in this subdivision;
- The rest part of Huizhou City, Shenzhen City, Dongguan City, Guangzhou City, Zhongshan City, Zhuhai City and Jiangmen City (not including Taishan city) in the Pearl River basin at middle part of Guangdong subregion. The Pearl River forms eight major outlets at the Pearl Delta;

- Yangjiang City in Moyang River basin at the middle west part of Guangdong subregion;
- Maoming City in Jian River at the west part of Guangdong subregion; and
- Zhanjiang City and Taishan of Jiangmen City at the west part of Guangdong subregion.  
There are tens of small rivers directly entering the SCS in this subdivision.

#### ***Guangxi subregion***

Three coastal cities from east to west are Beihai City, Qingzhou City and Fangcheng Port City. Nanliu River, the biggest river in Guangxi subregion directly flowing to the SCS, joins the SCS at Hepu County of Beihai City. Other rivers entered the SCS in Beihai City are Dafeng River, Baisha River, Tieshan River, Sanhe River, Qixing River, and Ximen River as well as several other small rivers. Qing River and Maoling River enter Qingzhou bay at Qingzhou City. In Fangcheng Port City, Fangcheng River enters Fangcheng Port bay, Beilun River, a boundary river between China and Viet Nam, enters the SCS.

#### ***Hainan subregion***

This subregion includes main island - Hainan Island which is the second biggest island of China and other offshore islands where there are small permanent population: Zhongsha Islands, Xisha islands as well as Nansha Islands in the South China Sea. Of nineteen cities and counties in Hainan subregion, thirteen coastal cities and Counties are: Haikou City, Qionghai City, Wenchang City, Qionghai City, Wanning City, Lingshui County, Sanya City, Ledong County, Dongfang City, Changjiang County, Danzhou City, Chengmai County and Lingao County. Haikou City and Qionghai City are located in Nandu River basin, Wanning City is in Wanquanhe River basin and Changjiang County is in Changhua River basin. Besides, there are many small rivers entering to the SCS.

#### ***Hong Kong subregion***

This subregion covers Hong Kong Peninsula and several islands at the east bank of Pearl Estuary. The urban area covers Hong Kong Island and Kowloon at Victoria Port. Only several small streams enter the SCS.

#### ***Macau subregion***

This subregion consists of Macau peninsula and two islands at the Right Bank of Pearl Estuary. There is no river or stream in it.

### **1.5 Physical Oceanography and Coastal Geomorphology of the SCS**

Survey conducted by China in seventies shows that the ocean current of the South China Sea is mainly under the control of warm current in northeast direction in summer and the maximum velocity is above 1 nautical mile per hour in most part of the sea. Whist the current is relatively complicated in the areas around Nansha Islands, of Beibu Gulf and around Hainan island, as is seen in Figure 1.5. In winter, the ocean current is very complicated. On one hand, warm current from Pacific goes through the seas around Philippine islands then drift to south China coast. On the other hand, cool current from northwest Pacific goes along China's coast in the direction from northeast to southwest, through Hainan Island and Beibu Gulf, then along Viet Nam's coast, finally to Gulf of Thailand, as is seen in Figure 1.6.



Figure 1.5 and Figure 1.6 show that, corresponding with ocean current, surface seawater temperature distribution is rather uniform and temperature difference is only one degree in all the South China Sea. Whist in winter, surface sea water isotherms parallel to coast of China, the temperature of surface sea water near China's coast due to the control of cool current is lower by 6 to 8 degrees than that far away from the coast.

Figure 1.7 and Figure 1.8 shows salinity in the SCS in summer and in winter respectively. Due to freshwater discharged to the SCS from land is much more in summer than in winter, iso-salinity is farther from coast in summer than in winter.

The SCS has four types of coastline in China part: silt bedrock bay, river delta, sandy bedrock bay and sandy plain. Figure 1.9 shows the length and location of all types of coastline.

## **1.6 Socioeconomic Information**

### **1.6.1 GDP**

It is known that China is a developing country. In the SCS coastal zone of China, averaged GDP per capita is only 10,143 RMB Yuans in 1996 although the SCS coastal zone is one of the most rapid economic developing areas in China in past twenty years. The three subregions of Mainland China are in the course of industrialization, its GDP service industry composes of 43.2% of GDP, manufacturing industry of 40.8%, and agriculture 15.8%. The GDP in 1996 of the SCS coastal subregions in Mainland China is shown in Table 1.3.

### **1.6.2 Import and Export**

Since China has carried out opening up policy, import and export in China's coastal zone at the SCS has increased quickly. Processing products, manufacturing products and agriculture products are main export commodities. The top ten export commodities of the SCS coastal zone in China and major countries/regions of destination are listed in Table 1.4. Steel, nonferrous metals, materials are major import commodities in the coast zone. The top ten import commodities of the coast zone in China and major countries/regions of origin are listed in Table 1.5.

### **1.6.3 Agricultural Production, Aquaculture and Forestry Production**

Agricultural production/aquaculture/forestry production involves a major part of total population in the SCS coast zone in China although GDP of agriculture/ aquaculture/ forestry sectors is only a small part in GDP. Due to dense population and family economy in countryside, only in a small part of the area used mechanical techniques are used. In the Pearl Delta, for instance, since the middle of 1980s, mechanized techniques have been introduced in rice plantation and aquaculture. Statistic data on agricultural production/aquaculture/ forestry production is listed in Tables 1.6 to 1.9.

### **1.6.4 Tourism**

Thanks to its unique natural scenery and splendid national culture, China's tourism is developing quickly in past years. The SCS coast zone is one of quickest tourism developing areas in China due to its favorite resources and geographical position.

With the increase of income, China's tourism will keep growing. Tourism information in the SCS coast area in China is listed in Table 1.10.



**Table 1.3 GDP in year 1996 (thousand RMB Yuan)**

| Subregion |                   | Agriculture | Industry  | Service   | Other Sectors |
|-----------|-------------------|-------------|-----------|-----------|---------------|
| Guangdong |                   |             |           |           |               |
|           | Chaozhou          | 3286350     | 5062820   | 4059110   | 707810        |
|           | Shantou           | 3787050     | 11702890  | 13673910  | 2207780       |
|           | Jieyang           | 5832190     | 1332620   | 6819090   | 1474510       |
|           | Shanwei           | 3221290     | 2022650   | 3165680   | 933030        |
|           | Huizhou           | 4655340     | 13088870  | 7932500   | 1758800       |
|           | Shenzhen          | 1570360     | 38238720  | 45621360  | 10109080      |
|           | Dongguan          | 2885450     | 12101420  | 8542490   | 985790        |
|           | Guangzhou         | 8116300     | 58145660  | 68838840  | 9662120       |
|           | Zhongshan         | 2194920     | 8833020   | 6532680   | 554140        |
|           | Zhuhai            | 1161430     | 8837740   | 8831740   | 1975020       |
|           | Jiangmen          | 6061500     | 18989940  | 16282110  | 1836080       |
|           | Yangjiang         | 5187970     | 2477250   | 3420230   | 683020        |
|           | Maoming           | 10004080    | 11512520  | 10586410  | 3001790       |
|           | Zhanjiang         | 9472110     | 9353750   | 10796260  | 2369670       |
|           | Subtotal          | 73415200    | 234491210 | 237856200 | 40478600      |
| Guangxi   |                   |             |           |           |               |
|           | Beihai            | 3101000     | 2228050   | 3834980   | 540840        |
|           | Qingzhou          | 5225070     | 1948540   | 3033390   | 1024790       |
|           | Fangcheng<br>Port | 1641750     | 851850    | 1241420   | 234930        |
|           | Subtotal          | 9967820     | 5028440   | 8109790   | 1800560       |
| Hainan    |                   |             |           |           |               |
|           | Haikou            | 249200      | 2570070   | 7067690   |               |
|           | Qionghai          | 1115480     | 1128500   | 881730    |               |
|           | Wenchang          | 1028670     | 606820    | 566410    |               |
|           | Qionghai          | 1468600     | 546970    | 765410    |               |
|           | Wanning           | 995050      | 645620    | 579350    |               |
|           | Lingshui          | 513520      | 156870    | 187360    |               |
|           | Sanya             | 846310      | 568570    | 716840    |               |
|           | Ledong            | 957170      | 123610    | 316900    |               |
|           | Dongfang          | 541360      | 465790    | 443860    |               |
|           | Changjiang        | 418210      | 531730    | 249600    |               |
|           | Danzhou           | 2315520     | 625430    | 1070640   |               |
|           | Lingao            | 1034430     | 118080    | 112600    |               |
|           | Chengmai          | 886340      | 606030    | 293390    |               |
|           | Subtotal          | 11959720    | 7440940   | 15406000  |               |

Table 1.4 List of top 10 Export commodities

| Commodities   | Production | Export  | Value (million<br>US\$ per year) | Major countries<br>/regions of destination  |  |
|---|------------|---------|----------------------------------|---|--|
| <b>Annually average of Guangdong province (1994-1996)</b> |            |         |                                  |   |  |
| Clothing  | N/D        | N/D     | 8644.43                          | Hong Kong, Taiwan,<br>Macau, Singapore,<br>Malaysia, USA, Japan,<br>Germany, Netherlands,<br>UK, France, Italy,<br>Australia, Canada<br>(exported Value > 10 <sup>8</sup><br>US dollars)              |  |
| Shoes (thousand pair)                                     | N/D        | 1284320 | 3416.75                          |   |  |
| Fabric  | N/D        | N/D     | 2938.29                          |   |  |
| Toys  | N/D        | N/D     | 2593.27                          |   |  |
| Articles for journey                                      | N/D        | N/D     | 1770.23                          |   |  |
| Plastic products  | N/D        | N/D     | 1669.04                          |   |  |
| Watch (thousand)  | N/D        | 692450  | 937.33                           |   |  |
| Telephone (thousand)                                      | N/D        | 11340   | 744.02                           |   |  |
| Furniture   | N/D        | N/D     | 715.53                           |   |  |
| Precious matters and jewelry (kg)                         | N/D        | 97879   | 664.33                           |   |  |
| Aquatic products(ton)                                     | N/D        | 160915  | 441.13                           |   |  |
| in which: living fish                                     | N/D        | 64638   | 142.98                           |   |  |
| frozen shrimp   | N/D        | 2814    | 17.47                            |   |  |
| <b>Annually average of Guangxi region (1995-1996)</b>     |            |         |                                  |   |  |
| Sugar (ton)   | 2073350    | 254108  | 91.56                            | Exported value > 10 <sup>8</sup> US<br>dollars: Hong Kong,<br>Japan, USA.<br>Exported Value > 10 <sup>7</sup><br>US dollars): Macau,<br>Netherlands, Germany,<br>France, Russia, UK and<br>Singapore. |  |
| Rosin (ton)   | 255775     | 76029   | 51.53                            |   |  |
| Cotton cloth (thousand meters)                            | 147740     | 73990   | 49.43                            |   |  |
| Pottery and porcelain (thousand)                          | N/D        | 794580  | 48.31                            |   |  |
| Can (ton)   | 208700     | 67848   | 43.43                            |   |  |
| Tin (ton)   | N/D        | 7098    | 42.78                            |   |  |
| Cement (ton)  | 19569950   | 920761  | 39.75                            |   |  |
| Barite (ton)  | N/D        | 1420906 | 32.90                            |   |  |
| Firework (thousand boxes)                                 | N/D        | 800     | 22.76                            |   |  |
| Paint (ton)   | N/D        | 29699   | 20.50                            |   |  |
| Aquatic products (ton)                                    | 1130352    | 2915    | 20.46                            |   |  |
| <b>Annually average of Hainan Province (1995-1996)</b>    |            |         |                                  |   |  |
| Ferroalloy (thousand ton)                                 | N/D        | 2280    | 59.87                            |   | Exported Value > 10 <sup>8</sup><br>US Dollars: Hong Kong,<br>Japan.<br>Exported Value > 10 <sup>7</sup><br>US dollars: USA,<br>Germany, Taiwan,<br>Russia, UK and<br>Singapore. |
| Antimony (ton)  | N/D        | 49206   | 30.82                            |   |  |
| Cotton cloth (thousand meters)                            | N/D        | 7200000 | 20.21                            |   |  |
| Pig iron (ton)  | N/D        | 92846   | 13.77                            |   |  |
| Pottery and porcelain (thousand )                         | N/D        | 57830   | 11.69                            |   |  |
| Silks and satins (thousand meters)                        | N/D        | 4220    | 10.19                            |   |  |
| Tin (ton)   | N/D        | 1429    | 8.47                             |   |  |
| Aquatic products (ton)                                    | 454107     | N/D     | 7.78                             |   |  |
| In which: frozen fish                                     | N/D        | 396     | 1.34                             |   |  |
| Shirt (thousand piece)                                    | N/D        | 1530    | 7.45                             |   |  |
| Gloves (thousand dozen)                                   | N/D        | 2340    | 6.73                             |   |  |

**Table 1.5 List of top 10 import commodities**

| Subregion | Commodities  | Total volume imported | Value (million US\$/a) | Major countries/region of origin  |
|-----------|--|-----------------------|------------------------|---|
| Guangdong | Annually average of Guangdong Province (1994—1996) |                       |                        |   |
|           | Steel products (ton)                               | 7184705               | 2837.46                | Hong Kong, Taiwan, Macau; Singapore, Malaysia, Indonesia; Japan, USA, Swiss, Germany, Canada, Russia and France |
|           | Electronic element                                 |                       | 1648.71                |   |
|           | Polystyrene (ton)                                  | 1860220               | 1635.52                |   |
|           | Paper & cardboard (ton)                            | 2606779               | 1212.31                |   |
|           | Oil (ton)  | 7674610               | 1070.68                |   |
|           | Cotton cloth (10 <sup>3</sup> m)                   | 1238870               | 948.34                 |   |
|           | Chemical fiber (10 <sup>3</sup> m)                 | 1375740               | 909.79                 |   |
|           | Leather (ton)                                      | 312635                | 832.57                 |   |
|           | Copper material (ton)                              | 294362                | 691.30                 |   |
| Machine   |  | 629.49                |                        |   |
| Guangxi   | Annually average of Guangdong Region (1995—1996)   |                       |                        |   |
|           | Fertilizer (ton)                                   | 345469                | 98.83                  | Hong Kong, Singapore, USA, Japan, Russia, Canada, Australia   |
|           | Sugar (ton)  | 2344154               | 82.46                  |   |
|           | Palm oil (ton)                                     | 70529                 | 53.27                  |   |
|           | Copper material (ton)                              | 91148                 | 30.21                  |   |
|           | Chemical material (ton)                            | 23563                 | 29.59                  |   |
|           | Metal ore (ton)                                    | 578785                | 26.96                  |   |
|           | Copper (ton)                                       | 7735                  | 13.83                  |   |
|           | Synthetic fiber (ton)                              | 6403                  | 12.18                  |   |
|           | Natural rubber (ton)                               | 8503                  | 12.16                  |   |
|           | Paper (ton)  | 9805                  | 6.88                   |   |
| Hainan    | Annually average of Hainan Province (1995—1996)    |                       |                        |   |
|           | Copper material (ton)                              | 265900                | 82.40                  | Russia, Ukraine, Hong Kong, Singapore, Japan, Viet Nam, USA, Korea, Germany, Italy                              |
|           | Fertilizer (ton)                                   | 261700                | 50.53                  |   |
|           | Oil (ton)  | 5880600               | 20.14                  |   |
|           | Medicine   | N/D                   | 8.52                   |   |
|           | Rice (ton)   | 68400                 | 6.38                   |   |
| Clothing  | N/D  | 2.82                  |                        |   |



**Table 1.6 Agricultural production**

| Subregion  | Value<br>(million Yuan) |      | Growth rate<br>per year<br>(%) | Involved<br>population | rowth Rate<br>per year<br>(%) | Type of<br>technology                      |
|------------|-------------------------|------|--------------------------------|------------------------|-------------------------------|--|
| Guangdong* | 57737                   |      | 8.09                           | 30,457,700             | 2.78                          | Mechanization<br>and half<br>mechanization |
| Guangxi**  | Beihai                  | 797  | 2.99                           | 1,007,700              | 0.35                          |  |
|            | Fangcheng<br>Port       | 489  | 13.09                          | 582,300                | 0.15                          |  |
|            | Qingzhou                | 2772 | 9.01                           | 2,723,700              | 0.65                          |  |
|            | Subtotal                | 4058 | 8.28                           | 4,313,700              | 0.38                          |  |
| Hainan*    | 3839                    |      | 8.92                           | 5,332,100              | 0.74                          |  |
| Total      | 65634                   |      | 8.43                           | 40,103,500             | 1.30                          |  |

Note: \* average of five years from 1992 to 1996

\*\* average of three years from 1994 to 1996

**Table 1.7 Fishery data**

| Subregion  | Production<br>(10 <sup>3</sup> ton) | Growth rate<br>per year (%) | Value***<br>(million Yuan) | Increase rate<br>(%) | Involved<br>population |
|------------|-------------------------------------|-----------------------------|----------------------------|----------------------|------------------------|
| Guangdong* | 1689.1                              | 6.78                        | 14985                      | 11.03                | N/D                    |
| Guangxi**  | 546.1                               | 23.62                       | 4845                       | 26.345               | N/D                    |
| Hainan*    | 349.3                               | 8.95                        | 1980                       | 15.81                | N/D                    |

Note: \* average of three years from 1994 to 1996

\*\* average of two years from 1995 to 1996

\*\*\* including the value of aquaculture

**Table 1.8 Aquaculture data**

| Subregion  | Production<br>(10 <sup>3</sup> ton) | Growth rate<br>per year (%) | Value**<br>(million Yuan) | Increase rate<br>(%) | Involved<br>population |
|------------|-------------------------------------|-----------------------------|---------------------------|----------------------|------------------------|
| Guangdong* | 1855.9                              | 17.34                       |                           | N/D                  | N/D                    |
| Guangxi*   | 461.4                               | 32.27                       |                           | N/D                  | N/D                    |
| Hainan*    | 82.9                                | 19.94                       |                           | 20.40                | N/D                    |

Note: \* average of three years from 1994 to 1996

\*\* Being included in the value of fishery

**Table 1.9 Forestry data**

| Subregion  | Production<br>(ton) | Growth rate<br>per year (%) | Value (million<br>Yuan) | Increase per<br>year (%) | Involved<br>population |
|------------|---------------------|-----------------------------|-------------------------|--------------------------|------------------------|
| Guangdong* | 147500              | 5.79                        | 1250                    | -1.30                    | N/D                    |
| Guangxi**  | N/D                 | N/D                         | 279                     | 1.96                     | N/D                    |
| Hainan*    | 188800              | 7.07                        | 2292                    | 7.84                     | N/D                    |
| Total      | 336300              | 6.43                        | 3821                    | 2.83                     | N/D                    |

Note: \* average of five years from 1992 to 1996

\*\* average of three years from 1994 to 1996

**Table 1.10 Tourism**

| Subregion  | Number of visitors (per year) |                     |                       |                         | Total number<br>Of hotel<br>rooms |
|------------|-------------------------------|---------------------|-----------------------|-------------------------|-----------------------------------|
|            | Domestic                      | Overseas<br>Chinese | From SCS<br>countries | From other<br>countries |                                   |
| Guangdong* | 26490500                      | 5008100             | 191001                | 883402                  | 148393                            |
| Guangxi**  | N/D                           | 128954              | 24632                 | 304952                  | N/D                               |
| Hainan*    | 3041698                       | 231791              | 12254                 | 40685                   | 20117                             |

Note: \* average of five years from 1992 to 1996

\*\* average of three years from 1994 to 1996

## 2. DETAILED ANALYSIS OF MAJOR WATER-RELATED CONCERNS AND PRINCIPAL ISSUES

### 2.1 Pollution

#### 2.1.1 Sources of Pollution

##### 2.1.1.1 Rivers

With a climate condition of tropical/subtropical monsoon, the SCS coastal area of China is rich in freshwater resources and has a dense river network. Twelve major rivers discharging into the SCS are: the Pearl River, Han River, Rong River, Moyang River and Jian River in Guangdong subregion, Nanliu River, Qing River and Maoling River in Guangxi subregion and Nandu River, Changhua River and Wanquanhe River in Hainan subregion. Averaged annual freshwater discharging into the SCS through rivers in China is listed in Table 2.2. The freshwater volume of the Pearl River, which is the largest one that enters into the SCS in China, composes 73.1% of total freshwater volume into the SCS from China.

**Table 2.1 Information of major rivers**

| Name of river | Length (km) | catchments area (km <sup>2</sup> ) | Freshwater volume (km <sup>3</sup> ) |
|---------------|-------------|------------------------------------|--------------------------------------|
| Han           | 410         | 30112                              | 24.10                                |
| Rong          | 185         | 4408                               | 2.81                                 |
| Pearl         | 2129        | 442100                             | 349.20                               |
| Moyang        | 199         | 6091                               | 5.95                                 |
| Jian          | 231         | 6091                               | 1.95                                 |
| Nanliu        | 287         | 8635                               | 6.83                                 |
| Qing          | 179         | 2457                               | 1.96                                 |
| Maoling       | 112         | 2959                               | 2.90                                 |
| Nandu         | 334         | 7022                               | 5.96                                 |
| Changhua      | 232         | 5150                               | 3.82                                 |
| Wanquanhe     | 157         | 3693                               | 4.95                                 |

**Table 2.2 River freshwater volume discharging into the SCS**

| Subregion |                                | River freshwater          |                |
|-----------|--------------------------------|---------------------------|----------------|
|           |                                | Volume (km <sup>3</sup> ) | Percentage (%) |
| Guangdong | Han River                      | 24.1                      | 5.0            |
|           | Other rivers in East Guangdong | 17.2                      | 3.6            |
|           | Pearl River                    | 349.2                     | 73.1           |
|           | All rivers in West Guangdong   | 31.7                      | 6.6            |
|           | Subtotal                       | 422.2                     | 88.3           |
| Guangxi   |                                | 24.9                      | 5.2            |
| Hainan    |                                | 31.0                      | 6.5            |
| Total     |                                | 478.1                     | 100            |

The rivers discharging to the SCS are the major pollution sources of the SCS. They receive a huge volume of industrial/domestic/agricultural/aquacultural wastewater from their drainage areas and discharge into the sea a large amount of such contaminants as SS, BOD, COD, nutrients (N & P), oil and heavy metals. The Pearl River, for instance, discharges through the eight outlets to the sea a significant volume of COD that is 87% of total COD load discharge through rivers from Guangdong Province. The watershed area of the Pearl River is 442,100 square kilometers. There are seven major cities in the Pearl River Delta. The seven cities are Guangzhou, Zhuhai, Dongguan, Zhongshan, Jiangmen, Foshan and Zhaoqing. Total population in the Pearl River Delta is over 20 million. The Pearl River Delta is in the course of urbanization and industrialization. Pollution loads of major rivers are listed in Table 2.3.

**Table 2.3 Pollution loads from major rivers**

| Subregion        | COD (ton/a) | Inorganic-N (ton/a) | Inorganic-P (ton/a) | SS (ton/a) | Oil (ton/a) |
|------------------|-------------|---------------------|---------------------|------------|-------------|
| Guangdong (1994) | 1472600     | 340050              | 3768.10             | 58531000   | 9697.8      |
| Guangxi (1996)   | 149936      | 8602                | 506.78              | N/D        | 822.96      |
| Hainan (1997)    | 3.63        | N/D                 | N/D                 | N/D        | 368.25      |

### 2.1.1.2 Coastal Cities and Coastal Population

There exist 14 coastal cities in Guangdong subregion, 3 coastal cities in Guangxi subregion and 13 coastal cities/counties in Hainan subregion. Among coastal cities/counties, only 15 cities/area discharge pollution directly to the sea. Other coastal cities and coastal population discharge pollution to the rivers, streams or channels. Section 2.1.1.1 has described the pollution sources of the rivers / streams / channels.

| Subregion | Major coastal cities/area                | Receiving waters |
|-----------|--|------------------|
| Guangdong | Shantou City                             | Shantou Port     |
|           | Shanwei City                             | Honghai Bay      |
|           | Daya Bay developing area of Huizhou City | Daya Bay         |
|           | Shenzhen City                            | Pearl Estuary    |
|           | Panyu City of Guangzhou City             | Pearl Estuary    |
|           | Zhuhai City                              | Pearl Estuary    |
|           | Taishan City of Jiangmen city            | Zhenhai Bay      |
|           | Zhanjiang City                           | Zhanjiang Port   |
|           | Haikang City of Zhanjiang City           | Leizhou Bay      |
|           | Leizhou City of Zhanjiang City           | Qingzhou Strait  |



|         |   |  |
|---------|---|--|
| Guangxi | Beihai City<br>Qingzhou City<br>Fangcheng Port City | Beibu Gulf<br>Qingzhou Bay<br>Fangcheng Port |
| Hainan  | Haikou City<br>Wenchang City<br>Sanya City          | Qingzhou Strait<br>Qinglan Port<br>Sanya Bay |

Municipal wastewater discharged into the sea is listed in Table 2.4. Municipal wastewater includes domestic and commercial wastewater and part of industrial wastewater discharged to the drains of the urban areas. The major pollution loads of municipal wastewater include SS, organic pollutants, and nutrients resulting in eutrophication and red tide.

**Table 2.4 Pollution and municipal population loads directly to the sea**

| Subregion        | Total Population | COD (ton/a) |                   | Inorganic-N (ton/a) |                   | Inorganic-P (ton/a) |                   |
|------------------|------------------|-------------|-------------------|---------------------|-------------------|---------------------|-------------------|
|                  |                  | To River    | Direct to the sea | To river            | Direct to the sea | To river            | Direct to the sea |
| Guangdong (1995) | 47918700         | /           | 54637             | /                   | 4028.12           | /                   | 523.63            |
| Guangxi (1995)   | 5088500          | /           | 7761              | /                   | 1164.70           | /                   | 87.11             |
|                  |                  |             |                   | Total-N             |                   | Total-P             |                   |
| Hainan (1997)    | 6100000          | 20353       | 27138             | 3052.81             | 470.76            | 4070.40             | 5427.67           |

### 2.1.1.3 Industrial Pollution from Coastal Installations

Industrial pollution source is a very important factor causing impact on marine environment. Industrial pollution loads to the sea not only result in seawater quality degradation, but also endanger marine ecosystem, marine biodiversity and habitats. In China, there are tens of coastal industrial centers of different size. Industrial pollution discharged directly to the sea from coastal installations is listed in Table 2.5. Only a small part of industrial pollution load from coastal cities/counties is listed in the Table. The rest from industrial installations located in the catchments of the rivers have been included in river pollution load and municipal pollution load.

Coastal waters receiving relatively more industrial pollution load from coastal installations are: the Pearl Estuary, Shantou Port, the Han River Estuary, Zhanjiang Port and Beibu Gulf near Beihai City.

**Table 2.5 Industrial pollutants to the sea from coastal installations**

| Subregion        | Wastewater (m <sup>3</sup> /a) | COD (ton/a) | Inorganic-N (ton/a) | Inorganic-P (ton/a) | Oil (ton/a) | Heavy metals (ton/a) | SS (ton/a) |
|------------------|--------------------------------|-------------|---------------------|---------------------|-------------|----------------------|------------|
| Guangdong (1994) | 55440000                       | 9494.9      | 260.95              | 16.23               | 133.87      | 22.906               | 12902.5    |
| Guangxi (1996)   | 24574670                       | 17401.9     | 108.73              | 1.06                | 52.98       | 2.742                | 4402.0     |
| Hainan (1997)    | 26309000                       | N/D         | N/D                 | N/D                 | N/D         | N/D                  | N/D        |
| Hong Kong        | 47960000                       | N/D         | N/D                 | N/D                 | N/D         | N/D                  | N/D        |

#### 2.1.1.4 Discharge from Upland and Low-land Based Activities

##### ● *Agriculture*

Pollution source from upland and lowland-based activities is a non-point source. Rice field, other seasonal crop field and plantations are major pollution sources from upland-based activities. The main pollution loads from these activities include BOD and nutrients (N & P), and therefore, are major factors resulting in eutrophication and red tide. Poultry/Livestock waste is another water pollution source. Aquaculture contributes to water pollution too.

South China is one of major regions of rice field and fruit plantation. Poultry/Livestock farms increased rapidly in recent years and scatter all over the coastal regions. Fruit, poultry and livestock not only meet domestic market demand but also are exported to other countries. It is estimated that loads discharge from agriculture/ poultry and livestock husbandry/aquaculture activities contribute a major part of organic loads and nutrients directly to the sea or through rivers. Agricultural/livestock husbandry/aquacultural sources are presented in Table 2.6.

**Table 2.6 Agricultural/animal husbandry/aquacultural sources (1995)**

| Subregion          | Rice field (ha)              | Other seasonal crops (ha)   | Plantations (ha) | Number of poultry(chickens, duck and quail) | Number of livestock       |
|--------------------|------------------------------|-----------------------------|------------------|---|---------------------------|
| Guangdong Province | 1698653                      | 618660                      | 885993           | N/D   | 50506900                  |
| Guangxi Region     | 1540300                      | 1073900                     | 922600           | N/D   | 33958400                  |
| Hainan Province    | 186341                       | 242844                      | 546725           | 73040000                                    | 6929200                   |
| Subregion          | Total fertilizer used(ton/a) | Total pesticide used(ton/a) | BOD ton/a        | Fresh water aquaculture (ha)                | Seawater aquaculture (ha) |
| Guangdong Province | 1957100                      | 80400                       | N/D              | 494500                                      | 1742300                   |
| Guangxi Region     | 1228600                      | N/D                         | N/D              | 150200                                      | 41000                     |
| Hainan Province    | 450985                       | 9023                        | N/D              | 40906                                       | 6931                      |

##### ● *Forestry*

South China needs timber import due to insufficient forest. In South China, forest area decreased before late 1980s whist it has increased year by year since late 1980s. Forestry information is presented in Table 2.7.

**Table 2.7 Forestry**

| Subregion | Land forest |                             | Mangrove   |                             | Erosion rate (m/a) | Timber production (m <sup>3</sup> /a) | Timber exported (%) | Other forestry products (ton/a) |
|-----------|-------------|-----------------------------|------------|-----------------------------|--------------------|---------------------------------------|---------------------|---------------------------------|
|           | Area(ha)    | Rate of loss (% , per year) | Area (ha)  | Rate of loss (% , per year) |                    |                                       |                     |                                 |
| GD P.     | 3205300     | 0                           | 3813(1990) | N/D                         | N/D                | 1986000                               | N/D                 | N/D                             |
| GX R.     | 6021700     | 0                           | 5654(1990) | N/D                         | N/D                | N/D                                   | N/D                 | 445062                          |
| HN P.     | N/D         | N/D                         | 4836(1990) | N/D                         | N/D                | N/D                                   | N/D                 | N/D                             |

Note GD P.—Guangdong Province; GX R.—Guangxi Zhuang Autonomous Region; HN P.—Hainan Province.



### 2.1.1.5 Ports and Harbors – Maritime Transport

With its favorable location, South China has many seaports and harbors including tens of small ones for fishing boats. There exist at least one sea port in each coastal city or county. In Figure 2.1 major sea ports and international and domestic sea-lanes are presented. Due to rapid development of economy in coastal zones and foreign trade, maritime transport and fishing in the South China Sea are very prosperous. China has hundreds of thousands of vessels. Among them eighty percent are fishing boats.

It is reported that 327 thousand vessels visited seaports in Guangdong Province in 1985, the number is 533 thousand in 1990, with an average increase rate of 10.5% per year. In the same period freight of oil vessel increased 6.5% per year. In 1990, Guangxi Zhuang Autonomous Region has 5734 maritime fishing motor vessels. 5560 vessels visited Beihai Port and Fangcheng Port in 1995.

The number of vessels (including fish boats and riverine ones) in three coastal province/region is listed in Table 2.8. Table 2.9 shows statistics of seaports and harbors.

**Table 2.8 Number of ships/boats**

| Province/Region | Motor vessel |                   | Barge  |                   | Sailing boat |                   |
|-----------------|--------------|-------------------|--------|-------------------|--------------|-------------------|
|                 | number       | Total net tonnage | number | Total net tonnage | number       | Total net tonnage |
| Guangdong p.    | 30432        | 7818419           | 1856   | 407991            | 41           | 2289              |
| Guangxi R.      | 9930         | 862542            | 300    | 81990             | 0            | 0                 |
| Hanna P.        | 1142         | 748967            | 75     | 22637             | 92           | 5147              |

**Table 2.9 Major seaports/harbors (1996)**

| Name of port | Vessel visits | Major cargo type                            | Volume of cargo transfer (10 <sup>3</sup> ton/a) |
|--------------|---------------|---|--|
| Chaozhou     | 2573          | Commodities, oil, coal, food, aqua-products | 230  |
| Shantou      | 15892         |   | 10820  |
| Jieyang      | 1308          |   | 60   |
| Shanwei      | 1972          |   | 480  |
| Huizhou      | 104           |   | 200  |
| Shenzhen     | 76419         |   | 29410  |
| Dongguan     | 1332          |   | 3320   |
| Guangzhou    | N/D           |   | 85160  |
| Zhuhai       | 8029          |   | 6100   |
| Zhanjiang    | 930924        |   | 17690  |
| Beihai       | 3081          |   | Commodities, oil, aqua-products                  |
| Qingzhou     | 2124          | N/D   |  |
| Fangcheng    | 486           | 5090  |  |
| Haikou       | N/D           | Commodities, oil, coal, ore                 | 9470   |
| Sanya        | N/D           |   | 310  |
| Basuo        | N/D           |   | 2650   |
| Yangpu       | N/D           |   | 540  |



**Part of major oil/natural gas terminals/ports is as follows:**

- |  |                      |
|--|----------------------|
| • Daya Port, Huizhou City, Guangdong Province        | oil terminal         |
| • Guangzhou Port, Guangzhou city, Guangdong Province | oil terminal         |
| • Shuidong Port, Maoming City, Guangdong Province    | oil terminal         |
| • Zhanjiang Port, Zhanjiang City, Guangdong Province | oil terminal         |
| • Weizhou Island, Be City, Guangxi Region            | oil terminal         |
| • Yanan, Sanya City, Hainan Province                 | natural gas terminal |
| • Dongfang, Dongfang City, Hainan Province           | natural gas terminal |

Discharge from vessels contains mainly oil. Averaged oil concentration in operational wastewater is about 2000 to 5000 mg/l. Effluent of operational wastewater treated by a separator contains oil lower than 15 mg/l. Due to lack of separators, poor public awareness and surveillance/monitoring capability, part of fishing boats discharge oily wastewater without treatment.

In 1980s number of oil spill accidents occurred in the South China Sea. In February 1984, for example, a ship run on the rocks near Henglan island at outer Pearl Estuary. 685 tons of oil discharged to the sea. In July 1989, a ship sunk at Shantou Port with 50 tons of oil discharging to the sea. It is reported that on average one serious marine accident occurs in near shore waters every one or two years and results in oil spills.

**2.1.1.6 Seabed Exploration and Exploitation**

In China seabed exploration and exploitation in the SCS is only for oil and natural gas. In China, seabed oil/natural gas exploration started in 1980s, the exploitation started in 1990s. In 1996, China exploited about 12 million tons of oil and 3.45 billion m<sup>3</sup> of natural gas in its continental shelf in the South China Sea. Over ten million m<sup>3</sup> of wastewater containing about 300 tons of oil was discharged to the sea from oil/natural gas exploitation of China in the South China Sea. Activities of oil/natural gas exploration in the South China Sea are increasing. Therefore, it is expected that wastewater and oil discharge to the sea from oil/natural gas exploration and exploitation will increase.

**2.1.1.7 Marine Dumping**

China government abides by 1972 London Convention and strictly bans marine dumping of productive and domestic wastes. China initiated a scheme of declaration requirement and license requirement for marine dumping in 1985. Regulation on Marine Dumping stipulates that any marine dumping activities must register with marine administrative authorities. Licensed dumping in the South China Sea is only dredged sediment.

**2.1.1.8 Atmospheric Inputs to the Aquatic Environment**

Study on atmospheric inputs to the aquatic environment is insufficient in China. Acid rain to the aquatic environment is the major concerns. In the coastal areas, acid rain results mainly from local airborne emission and long distance transportation. Due to massive fossil fuel consumption, the Pearl River Delta and surrounding areas become an acid rain center. Airborne emission data is shown in the Table 2.10.

**Table 2.10 Airborne emission (1995)**

| Subregion | Coal consumption (ton/a) | Oil consumption (ton/a) | Number of cars, trucks, etc. | Number of MC | Forest fire | Volcano |
|-----------|--------------------------|-------------------------|------------------------------|--------------|-------------|---------|
| Guangdong | 37,695,149               | 10,967,779              | 1,525,206                    | 3,429,133    | N/D         | no      |
| Guangxi   | 23,298,500               | 1,764,500               | 609,637                      | 456,925      | N/D         | no      |
| Hainan    | 1,647,139                | 361,575                 | 125,113                      | 162,161      | N/D         | no      |

### 2.1.2 Pollution Hot Spots

China has a large coastal population, long coastline and many pollution discharge points. Pollution hot spots are defined using following criteria:

- Relatively larger Riverine loading to the sea;
- Coastal city/cities with population > 40,000; and
- Pollutants, which may significantly affect or have potential serious impact on public health, economy, freshwater/marine ecosystems and biodiversity.

Amount of wastewater, COD, nutrients (N & P), suspend solids and oil discharged to the sea are taken as major elements in assessing pollution hot spots.

| Pollution hot spot              | Major coastal city/cities                               | Main pollutants    |
|---------------------------------|---|--------------------|
| Han River mouth to Shantou Port | Shantou   | COD, nutrients, SS |
| Pearl Estuary                   | Hong Kong, Shenzhen, Dongguan, Guangzhou, Zhuhai, Macau | Bitto              |
| Zhanjiang Bay                   | Zhanjiang   | Bitto              |
| Coastal water near Beihai City  | Beihai City   | Bitto              |
| Coastal water near Haikou City  | Haikou  | Bitto              |

Above pollution hot spots relate pollution receiving waters and source cities and main pollutants as well. Locations of the pollution hot spots and associated cities are shown in Figure 2.2. COD, oil and ammonia nitrogen loads to the hot spots from major cities are presented in Figure 2.3. Municipal wastewater and industrial wastewater discharged directly to the sea from coastal areas are presented in Figure 2.4 and Figure 2.5, respectively.

### 2.1.3 Sensitive and High Risk Areas

#### 2.1.3.1 Sensitive Areas

The sensitive areas means those river mouths and near shore waters with relatively high social/natural value and the value easily damaged by pollution. Sensitive areas in China part are as follows:

| Subregion | Seawater  | Sensitive element           |
|-----------|---|-----------------------------|
| Guangdong | Green turtle preserve at Huidong Port                       | green turtle                |
|           | Aquatic resource preserve at Daya Bay                       | living aquatic resources    |
|           | Pearl Estuary   | living aquatic resources    |
|           | Futian natural preserve at Deep Bay                         | mangroves                   |
|           | Zhanjiang mangrove protected area                           | mangroves                   |
| Guangxi   | Haikang “White butterfly” shellfish Preserve at Leizhou Bay | “White butterfly” shellfish |
|           | Dugong preserve at Tieshan Port Bay                         | Dugong                      |
|           | Shankou mangrove preserve at Tieshan Port Bay               | mangrove                    |
|           | Silver beach and scenic spots near Beihai City              | beach and natural landscape |
|           | Coastal waters near Beihai City                             | living aquatic resources    |
| Hainan    | Mangrove reserve at Beilun River mouth                      | mangroves                   |
|           | Coastal waters near Haikou City                             | beach                       |
|           | Mangrove reserve at Dongzai Port                            | mangroves                   |
|           | Coastal water near Sanya City                               | beach                       |

### 2.1.3.2 High Risk Areas

The high-risk areas mean those sensitive areas or other near shore waters, which may be easily damaged by or threatened with pollution or human activities.

| Subregion | High risk areas                              | Risk factor  |
|-----------|--|--|
| Guangdong | Daya Bay, Huizhou City                       | <ul style="list-style-type: none"> <li>● aquatic resources;</li> <li>● pollution from Daya Bay developing zone,;</li> <li>● risk oil spills resulting from oil terminal</li> </ul>   |
|           | Pearl Estuary                                | <ul style="list-style-type: none"> <li>● aquatic resources; mangrove ecosystems;</li> <li>● pollution from rivers/coastal cities and population/ coastal industries;</li> <li>● waste and oil spills from maritime activities/ports/ harbors/ oil terminals</li> </ul> |
|           | Shuidong Port, Maoming City<br>Zhanjiang Bay | <ul style="list-style-type: none"> <li>● oil spills from oil terminal</li> <li>● mangrove ecosystems;</li> <li>● pollution from coastal cities and population/coastal industries;</li> <li>● waste and oil spills from maritime activities/ ports/ harbors</li> </ul>  |
| Guangxi   | Tieshan Bay, Beihai City                     | <ul style="list-style-type: none"> <li>● mangrove ecosystem;</li> <li>● Dugong;</li> <li>● Pollution from coastal population/agriculture</li> </ul>  |
|           | Coastal waters near Beihai City              | <ul style="list-style-type: none"> <li>● beach;</li> <li>● scenic spots;</li> <li>● pollution from rivers/ Beihai City/coastal industries</li> </ul>   |
| Hainan    | Coastal waters near Haikou City              | <ul style="list-style-type: none"> <li>● beach;</li> <li>● pollution from Nandu river/ Haikou City/coastal industries</li> </ul>   |
|           | Coastal waters near Sanya City               | <ul style="list-style-type: none"> <li>● beach;</li> <li>● pollution from rivers/ Sanya City and population/ coastal industries;</li> </ul>  |
|           | Yangpu Bay                                   | <ul style="list-style-type: none"> <li>● industrial pollution</li> </ul>   |

Sensitive areas and high-risk areas are mapped on Figure 2.6 and Figure 2.7, respectively.



## **2.2 Freshwater Shortage and Degradation of Its Quality**

### **2.2.1 Surface Water**

#### **2.2.1.1 Resources of Surface Water and Current Status**

In general, south China is rich in surface water. In a major part of the coastal zone, surface water can meet the demand of drinking water and production water. Due to uneven spatial distribution of freshwater a part of the coastal areas has a shortage of fresh water. In some densely populated coastal areas without river and offshore islands, fresh water shortage is very serious.

Rainwater is main source of surface water. Groundwater composes only a small part of the sources. Due to uneven temporal distribution of precipitation, in a year, the averaged surface water volume from April to October composes eighty- percent or more whist that of the rest months composes only twenty-percent or less. Besides, surface water significantly varies yearly in the coastal areas.

- ***Guangdong Subregion***

Averaged surface water in the subregion is 323 km<sup>3</sup> per year. Among that only 95.5 km<sup>3</sup> per year of surface water comes from local areas. The Pearl River basin, Han River basin, Jian River basin and other river basins are rich in surface water. However, the areas in the Middle East part and the west wing with only short rivers, particularly Zhanjiang City and Leizhou Peninsula and island in the Pearl Estuary, are lack of surface water.

- ***Guangxi Subregion***

Total averaged surface water volume is about 25 km<sup>3</sup> per year. Because precipitation is only 1000 to 1600 mm per year, Beihai City except Nanliu River basin in the East part has a lack of surface water.

- ***Hainan Subregion***

The rivers flow from the middle mountainous country outward into the sea. In the west part particularly the North west part and South West part, averaged yearly precipitation is only about 1000 mm. Therefore, above mentioned areas are lack of surface water.

- ***Hong Kong Subregion***

There are only several small rivers in the area. Water shortage is very serious. Ninety-percent of water supply comes from the East River of the Pearl River.

- ***Macau Subregion***

There is no river in the area. All water supplies in the subregion come from the Pearl River.

#### **2.2.1.2 Demand and Shortage of Surface Water**

In south China, demand of surface water by agriculture takes about eighty percent. In Leizhou Peninsula and west part of Hainan Province, surface water cannot meet the demand by agriculture and drinking water.

Areas affected by low quality surface water include Guangzhou City, Chaozhou City, Shantou City, Fuoshan City and Maoming City. Due to no larger rivers, the areas with surface water shortage include Daya bay Developing zone, Shenzhen City, Hong Kong, Macau, Zhanjiang City and Beihai

City. Surface water needs to be transported from rivers or reservoirs 30-50 kilometers away to these areas.

***Problems in the impact areas with surface water shortage are:***

- In the coastal areas from Huilai County to Haifeng County in Middle-East part of Guangdong Province, surface water is short for agriculture use.
- In Leizhou Peninsula in west Guangdong Province. Surface water is short for agriculture use and drinking water.
- In west part of Hainan Province, surface water is short for agriculture use and drinking water.

## **2.2.2 Issue of Lancang River**

Lancang is a transboundary river. Originating from the north foot of Tanggula Mountains, it flows in Tibet Autonomous Region and Yunnan Province in China, Laos, Burma, Thailand and Cambodia, and finally empties into the South China Sea in Viet Nam. The river is also called Mekong River in other countries. The length of the river in China is 2,161 kilometers. The watershed area in China is 167,486 km<sup>2</sup>. The averaged annual water volume in China is 76 km<sup>3</sup>. The Lancang River basin is seen in Figure 2.8.

The river basin in China is an economically backward area with few industrial pollution sources. The monitoring results in China indicate that water quality of Lancang River is quite good. Affected by global change of climate, the basin became worse and worse in forest and vegetation degradation and soil erosion. This results in heavy pressure on water conservation and flood control in the area particularly in lower reaches. On the other hand, economically backward and population increase in the area form pressure on the environment and make the problem of forest decrease and soil erosion worse and worse. Total population in the area increased 12.1% from 1982 to 1990.

## **2.2.3 Groundwater**

### ***2.2.3.1 Current Groundwater Status***

In general, the coastal area of South China is rich in groundwater with total annual volume of groundwater 24.89 km<sup>3</sup>. Among that, Guangdong Province and Hainan Province have annual volume of 23.88 km<sup>3</sup>, the rest (1.01 km<sup>3</sup>) exists in Guangxi subregion.

### ***2.2.3.2 Groundwater Extraction and Current Status***

In South China, only in such cities where surface water is short as Shenzhen City, Haikou City and Beihai and in rural areas groundwater is extracted for drinking water and industrial use. In Guangdong Province and Hainan Province current volume of groundwater extraction is 2512 thousand M<sup>3</sup> a day which takes twenty two percent of the total daily extractable volume. In Guangxi subregion, current volume of groundwater extraction is 164 thousand M<sup>3</sup> a day.

### ***2.2.3.3 Areas with Shortage or Low Quality of Groundwater***

Groundwater extraction is a supplementation to surface water. In Zhanjiang City and Leizhou Peninsula, over-extraction of groundwater has resulted in lower water table, reduction of extractable volume and degradation of water quality. In some areas in Shenzhen City, Zhanjiang City and Beihai City, groundwater has been polluted, therefore cannot serve as drinking water supply.



## 2.3 Exploitation of Living Aquatic Resources

### 2.3.1 Living Freshwater Resources

#### 2.3.1.1 Current Status

Living freshwater resources in the coastal area of SCS are mainly comprised of the resources from Guangdong Province, Hainan Province and Guangxi Zhuang Autonomous Region. As for the quantity of freshwater and scale of rivers, Guangdong ranks the first while Guangxi and Hainan are relatively smaller. Living freshwater resources of Guangdong are therefore account of a large percentage among that of coastal area of SCS.

Existing data has indicated that hydrophyte, benthos and plankton in the estuaries of rivers entering into the SCS are very rich. The average biomass in estuary of Pearl River of Guangdong Province is 36.61 g/m<sup>3</sup> while that in the west and east of Guangdong is 100.68 g/m<sup>3</sup> and 89.82 g/m<sup>3</sup> respectively.

The average distribution of estuarine creature in Hainan Province is: 73.25 g/m<sup>2</sup> of biomass and 159 individual/m<sup>2</sup> of creature density. Due to the difference of geographic environment of the rivers entering into the SCS, an unique characteristic of living freshwater resources of Hainan Province has been formed: tropical species of living resources tack a large portion. During the wet season a large quantity of freshwater flows into the estuary while in dry season a large amount of oceanic fish enters into the estuary due to flow distance of the rivers here are relatively short, most being within 100 km.

There are a limited number of small scope rivers entering into the sea in Guangxi. Taking Dafeng River month as an example, fish resources is 1.78 t/km<sup>2</sup> and benthos is 50-100g/m<sup>2</sup>. This river month is also a breeding zone of natural oyster.

There are over 300 species of freshwater fish in inland rivers of Guangdong coastal area and among which 208 are species of pure freshwater fish, 7 are migration one and others are marine fish frequently or accidentally appear in the estuaries. Among freshwater fishes half are economic fish which mainly include Carp, Crucian Carp, Grass Carp, Big-head Carp and Black Carp. The yield of 1996 is 80.9 thousand ton with annual increase of 9.9 %. The aquaculture area of the whole province is 350.8 thousand hectares with annual increase of 6.4%. Besides, aquaculture freshwater species also include river shrimp, river crab, turtle and so on. This has become an important sector of rural economy.

There are 200 species of freshwater fish in inland rivers of Hainan coastal area and among which 106 are species of pure freshwater fish, 94 are estuary one. The freshwater yield of 1996 is 9.3 thousand tons and freshwater aquaculture yield is 74.1 thousand ton with the aquaculture area of 42.2 thousand hectares.

In Guangxi, the freshwater harvest of 1996 is 62.3 thousand tons, cultivation yield is 444.6 thousand tons and cultivation area is 208.9 thousand hectares.

The utilization of freshwater resources is shown in Table 2.11.



**Table 2.11 Current utilization of freshwater resources**

| Region    | Fish harvest (ton/y) | Fish MSY (ton) | Bottom layer fish MSY | Invertebrat harvest (ton/a) | Invertebrate animal MSY | Freshwater culture yield (ton/a) |
|-----------|----------------------|----------------|-----------------------|-----------------------------|-------------------------|----------------------------------|
| Guangdong | 80900                | N/D            | N/D                   | N/D                         | N/D                     | 1766900                          |
| Hainan    | 9278                 | N/D            | N/D                   | N/D                         | N/D                     | 83340                            |
| Guangxi   | 62338                | N/D            | N/D                   | N/D                         | N/D                     | 506901                           |
| Total     | 152516               | N/D            | N/D                   | N/D                         | N/D                     | 2357141                          |

Note: MSY—Maximum Sustainable Yield

Due to unreasonably using fishing gears and fishing methods, overfishing and pollution of part lakes and rivers, living resources has tended decrease. Recently, the situation has changed gradually because the management of the major water resources that area has been strengthened. Particularly, due to great development of freshwater aquaculture, harvest of aquaculture has exceeded harvest far of fish catching. This means that meeting the need to freshwater living resources no longer depends on the natural source.

#### 2.3.1.2 Endangered/Transboundary/Migratory Species

The distribution of endangered and migratory species in the coastal area of SCS is as follows:

Species of endangered freshwater fish of Guangdong Province include: *Acipenser sinensis* Gray, *Angailla marmorata*, *Tanichthys albonubes* Lin, *Dasyatisakajei* (mitaer et Hewe), *Angailla japonics* Temmindk et Schlegel, *Anguilla nigricans* chu et Wu, *Macrura reevesi* (Richardson) and etc.

Species of endangered freshwater fish of Hainan Provinces include *Angailla marmorata*, *Angailla japonics* Temmindk.

#### 2.3.1.3 Key Problem / Focus

- **Overfishing**

Overfishing has caused a number of economic fish species to be endangered or rare species such as: *Acrossocheilus beijiangensis*.

- **Water body pollution**

Water pollution in lower course of Pearl River and estuaries is severe, fish and shrimp is hard to be found in some severe polluted river courses.

#### 2.3.1.4 Economic Losses Because of Over-exploitation

- Predatory exploitation of freshwater aquatic resources has caused the yield of economic fish reduce dramatically and lead to economic loss directly or indirectly.
- The devastation of habits of living freshwater resources severely influence the breeding places of some species of fishes and caused the recession of population.

#### 2.3.1.5 Market Situation

With the decrease of freshwater living resources in coastal area, the natural resources can not meet the needs home and outside. But the freshwater resources have been complemented with the rapid development of artificial freshwater cultivation. The supply and needs are basically balanced in Guangdong, Guangxi and Hainan, the marketing situation of aquatic product of Guangdong is taken as the example.

The sales of aquatic product of Guangdong Province in 1994 is 1.5197 million tons, the storage of yearend is 53.9 thousand tons; sales in 1995 is 842.1 thousand tons and yearend storage is 27.2 thousand tons, in 1996 sales is 831.6 thousand tons and storage is 27.2 thousand tons. It is shown that that the sales of aquatic product have a trend of decrease.

#### ***2.3.1.6 Impacts of Global Change***

The impact on freshwater living resources of SCS coastal area by globe change are mainly come from climate change such as Greenhouse and El Nilo effect.

Due to global climate Change, unequal precipitation distribution, excessive rain, flood and soil erosion, the silt content in rivers has increased, the turbidity of water has risen, and the habitats of living aquatic resources have been destroyed. Some pollutants from inland entered into rivers together with polluted surface runoff have posed an aquatic ecosystem severely. In recent years in Guangdong Province, is continuously influenced by natural calamities such as flood, typhoon, tornado and drought. Flood occurred in Pearl River Delta area has resulted in losses of fishery industry while the drought has caused the rivers dried up in Leizhou Peninsula and led to direct economic losses of hundreds million Yuan (RMB) of aquatic products industry.

Besides, rise of water temperature caused by global climate change has impact on disadvantageous living freshwater resources.

#### ***2.3.1.7 Countermeasures***

##### **(1) Strengthening control and management of industrial pollution source**

Industrial wastewater is the major pollution source for regional freshwater. In China coastal area bordering SCS the total quantity of wastewater discharged from outlets is 154,285 thousand tons in while that from Guangdong Province, Guangxi Autonomous Region, Hainan Province and Hong Kong are 51,440 thousand tons, 26,309 thousand tons, 47,960 thousand tons respectively in 1995.

In past ten years, the treatment of industrial wastewater has been strengthened in Guangdong Province. Comprehensive management of industrial pollution sources with legal, economic and administrative measures has also been carried out. The Effluent Standard of Water Pollutants of Guangdong Province, The Environmental Management Regulation for Construction Projects of Guangdong Province and more than ten local environmental protection laws, regulations and standards have been promulgated successively. In 1996, the dispensing rate of "Three Simultaneous Principal"\* for construction projects in Guangdong Province has got to over 86% while that of the large- and medium-sized projects reached to 100%. Industrial wastewater treatment rate and standard compliance rate were 71% and 57% respectively.

##### **(2) promoting treatment of municipal sewage**

Exiting data indicate that in 1995 the total quantity of municipal sewage of China coastal area of SCS is 495329.1 thousand tons among from Guangdong, Guangxi and Hainan are 274,118.8 thousand tons, 89,070.3 thousand tons and 132,140 thousand tons respectively. The governments at all level pay increasingly attention to municipal sewage treatment. The secondary sewage treatment plants have been set up in Guangzhou, Shenzhen and Zhuhai

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\* "Three Simultaneous Principal" is environmental protection policy of China. It requires that environment protection facilities must be designed, constructed and put in operation simultaneously with the principal for a new project.



cities. In Guangzhou the extension project of Datansha Sewage Treatment Plant has already been finished and the Liede Plant is being built now. In Shantou and Zhanjiang cities some sewage plants will be built. Mawan sewage sea disposal project in Shenzhen, the first sea disposal project in China, provided a demonstration of this kind projects. All above-mentioned measures have important effect on protecting living aquatic resources in the area.

### **(3) Promoting ecological agriculture**

As an effective way to eliminate agriculture pollution, ecological agriculture can greatly reduce the impact of chemical fertilizer and pesticide on living freshwater resources. Huadu City, the famous vegetable base of Guangzhou City, is also a typical region of developing ecological agriculture, the agriculture products produced from the city have a good sale in whole country, at the same time economic, social and environmental benefits have been achieved.

Besides, it is also an effective measure for protecting living freshwater resources to construct municipal ecological demonstration region. In a number of cities and counties in Guangdong, such as Zhuhai, Zhanjiang, Lianjiang and Zencheng ecological cities are being pursued.

### **(4) Prohibiting overfishing freshwater living resources, restoring aquatic ecological balance**

Overfishing has caused a lot of species of economic fish to be endangered or rare one. To protect the spawner and fish fry the aquatic product departments have designated fishery preserves in large reservoirs and rivers and prohibit fishing in the zones; meanwhile, bred fish fry to freshwater. For instance, Zhongshan Aquatic Bureau of Guangdong Province breeds 10 million fish fries in Pearl River Mouth every year. This has momentous effectiveness in protecting and recovering living aquatic resources.

### **(5) Protecting the population of living freshwater resources.**

The quantity of some rare species and economic fish has reduced sharply. For example, the catch yield of black carp, grass carp, silver carp and variegated carp, the famous "Four Species of Fish Cultivated" in China, has gone down to 20% -- 30% of the total yield of freshwater fish in the country nowadays from 50% of that in middle 1960's. It is the most effective way of protecting fishery resources to safeguard fish natural breeding grounds and to protect the reproduction population. For this purpose, the ecological store has already been set up in Yanze River (Changjiang) few years ago and will be spread in the whole country.

### **(6) Invitro-culture of living freshwater resources**

In order to lastingly store and sustainable utilize fish resources, it is necessary to refrigerate fish sperm and embryo. In China, considerable progress for refrigeration of fish sperm has been made and this measure has already been applied to practice for "Four Species of Cultivated Fish".

### **(7) Controlling pollution load from inland**

Since late of 1980's a series of comprehensive river regulation projects have been constructed in Guangdong Province, such as Guangzhou section of the Pearl River, Cangjiang River, Qijiang River, Shenzhen River, Xiaodongjiang River and Qianshan River. In addition, river water quality management has been strengthened, a whole set of laws and regulations have been promulgated, the "Clean River Water Project", with 20 million Yuan (RMB) of investment, is being carried out now in Guangdong Province will significantly reduce pollutants to the sea.



## 2.3.2 Living Marine Resources

### 2.3.2.1 Current Status

There are plenty species of living marine resources in SCS, including 15 species of *Reptilia* such as sea turtle, sea snake, nearly 1,000 species of fish most of which is warm water fish, over 2,000 species of plankton and various benthos (see Fig. 2.9 and Fig. 1.0). Natural catch is dominant and aquaculture is a supplement in marine fishery. In the shallow waters with an area of 135 Km<sup>2</sup> of north SCS and Beibu Gulf, the annual allowed fish catching yield is 489.3 thousand tons from the water depth of less than 40 meters. While the yield is 397 thousand tons and 260 thousand tons from 40 – 90 meters and 90 - 120 meters depth respectively. The total allowed catch yield is 996 thousand tons each year. There exists 39 fishing grounds with total area of 530,000 Km<sup>2</sup> in SCS of China, including east Guangdong, west Guangdong, Beibu Gulf, Xisha Island, Dongsha Island, and Nansha Island. Most of this ground mainly distribute in offshore of north SCS in which the water depth is less than 40 m. In these regions the primary production capacity is higher and fishery resources are abundant. The fish resources in SCS can be calculated as follows:

If 40 gram carbon are produced from each square meter water area, and the ecological efficiency is 15%, then the fish yield from middle and upper layers of waters is 1.4 tons / Km<sup>2</sup> in shallow water while the yield is 0.7 tons/Km<sup>2</sup> in offshore waters. Therefore, the theoretical annual catch yield from the 3,500 Km<sup>2</sup> total area of SCS is 9,450 thousand tons. If only 50% of the theoretical yield is accounted, then the maximum sustainable yield can be 4,720 thousand tones. Among which, the fish catch from middle and upper layers of waters can be over 2,480 thousand tons, the bottom fish yield from offshore can be 1,660 thousand tones, the bottom fish yield of deep sea can be 580 thousand tons.

It is indicated in “The Comprehensive Investigation Report on Island Resources of Guangdong Province” that the swimming organisms are the major marine fishery resources of marine waters around the islands of Guangdong Province. It account for 97% of marine catch yield of the province, in which fish is the major population of swimming organisms and comprise of 90% of the total biomass”. Therefore the catch yield of fish and marine invertebrate animal from different sea areas of Guangdong Province, Guangxi Autonomous Region and Hainan Province can be estimated (Table 2.12).

**Table 2.12 Utilization of current marine resources**

| Regions   | Middle and upper fish harvest (ton/y) | Middle and upper layer fish MSY (ton) | Bottom fish Harvest (ton/y) | Bottom fish MSY | Marine invertebrate Harvest (ton/y) | Marine invertebrate MSY | Aquatic Production Yield (ton/y) |
|-----------|---------------------------------------|---------------------------------------|-----------------------------|-----------------|-------------------------------------|-------------------------|----------------------------------|
| Guangdong | 790,110                               | N/D                                   | 711,100                     | N/D             | 218,390                             | N/D                     | 2183,900                         |
| Hainan    | 170,143                               | N/D                                   | 153,129                     | N/D             | 47,028                              | N/D                     | 392,400                          |
| Guangxi   | 275,271                               | N/D                                   | 247,744                     | N/D             | 76,085                              | N/D                     | 727,200                          |
| Total     | 1235,524                              | 2480,000                              | 1111,973                    | 2240,000        | 341,503                             | N/D                     | 3303,500                         |

Note: MSY – Maximum sustainable yield

Aforementioned analysis shows that the total fish catch of the three provinces / regions bordering on SCS is 2,689.1 thousand tons, if the yield of other provinces or surrounding countries is included, the total fish yield maybe exceed the maximum sustainable yield of SCS. Experts point out that the dominant economic fish population in coastal waters and shallow offshore waters in north SCS is reducing gradually. The decreasing trend of catch efficiency also shows that the catch intensity has already exceeded natural reproduction capacity of fishery resources, so it is a pressing task to protect marine resources.

### **2.3.2.2 Endangered / Transboundary / Migratory Species**

The endangered marine species include Dugong, *Tridacna (Dinodacna) cookiana*, *Corallium japonicum*, *Bahaba favolabiata*, *Glossobalanus polybronchioporus*, *Saccoglossus hwangtauensis*, *Cassia (Cecornata)*, *Natilus pompilius*, *Branchiostoma beleheri*, *Cypraetigris Linnaeus*, *Gassidiadae*, *Pinctada maxima (Jameson)*, *Chelonia mydas*, *Eretmochelys imbricata*, *Balaenoptera acturostrata*, *Balaenoptera acturostrata*, *Delphinus*, baleen whale, fish whale, pilot whale, pollack whale, etc.

The transboundary species include shark, tuna, Dugong, Sparidae, *Ilisha elongata (Bennett)*, *Nemipterus virgatus (Houttuyn)*, *Stromuleidae*, etc.

### **2.3.2.3 Key Issues / Focus**

#### **(1) Effect of over-fishing on living marine resources**

Because of over-fishing, the marine ecological species has been utilized fully, and the fish resources are declining. The fish catch yield is unstable in offshore waters of Guangdong in recent years, the fact shows that the living marine resources is reducing and there is no fishery development potentiality in coastal waters of SCS.

#### **(2) The impact of marine pollution on living marine resources**

Due to discharging of domestic sewage and industrial wastewater, extensive use of chemical fertilizer and rapid development of marine aquaculture, the coastal waters are polluted gradually and a part of waters is eutrophic in recent years. From October 1997 to May 1998 an unprecedented red tide occurred in South Fujian Province, East Guangdong, West Guangdong and the estuary of Pearl River, as a result, the fish and shrimp cultured in net pens all died.

Because of sea dumping, oil-spill and chemical leakage the marine resources were harmed directly and the marine biodiversity reduced obviously in Shantou harbor, Zhanjiang harbor and Pearl River Estuary.

### **2.3.2.4 Losses Because of Over-exploitation**

In the early 1970's the average yield per horsepower is 1.51 tons for motor fishing boats while the yield reduced to 0.55 tons in 1983, namely went down by 66%. At the same time the quality digression of species of caught fish also shown the decrease of fishery economic benefits. From 1963 to 1983 the proportion of high quality fish population caught has already fallen sharply by a big margin: from 10.03% to 2.9% for *Lutianus*, from 16.7% to 5.3% for *Tuna* and from 9.8% to 5.2% for *Ilisha*.

Sewage discharge and unreasonable marine aquaculture made the waters eutrophic; bloom has already become the ordinary disaster for coastal waters. For example, the alga bloom, which occurred in SCS from March to April 1998, caused direct economic losses of 200 million Yuan (RMB).

According to statistic data, 442 fishery pollution accidents occurred in 13 provinces / regions in 1993 and result in economic losses of 42 million Yuans (RMB).

### **2.3.2.5 Market Demand**

It is essentially the same to demand of living freshwater resources.



### 2.3.2.6 Impact of Global Change

The impact of climate warming-up and sea level rise on coastal ecological system is as follows:

- (1) Seawater warming-up is advantageous for expansion of biological geographical zone that consists of coral reefs, mangroves and tide-marsh community.
- (2) Sea level rise will make tidal zone community move to land and accelerate growth of coral reefs. Great number of mangroves will vanish. Level rise will reduce the marsh areas distributing in lower places, especially seriously impact the coastal mangrove marshes, narrow the habitats of fish, shrimp and sea turtle. Temperature rising by 2 or 3 degrees will result in death of many coral polyps and seriously affect various marine organisms roosting on the coral reefs.

### 2.3.2.7 Countermeasures

#### (1) Setting up marine nature preserve

Marine nature preserve has important strategy significance for protection and sustainable use of biodiversity. The governments at all levels have set up a lot of preserves for living marine resources in the SCS.

#### *Guangdong Province*

- Pearl Estuary Preserve for Breeding Ground of Economic Fish, which located in the waters bordering Shenzhen, Zhuhai, Panyu and Dongguan cities.
- Huidong Sea Turtle Preserve, with total area of 1,400 ha, which located in Huidong County, a breeding area for sea turtle.
- Daya Bay Aquatic Resources Preserve, Huiyang City, with 300 species of fish, 506 species of shallow water benthos and 253 species of island tidal zone organisms. The protect objects are: pearl shellfish, precious fish, shrimp and algae.
- Yamen Outlet Preserve for breeding ground of economic fish.
- Haikang White-butterfly Shellfish Preserve.
- Wanshan Archipelago and Around Waters Preserve, the representative of subtropical estuary ecosystem in China, located at outer Pearl Estuary. The protection objects are estuary and marine ecosystem and species, especially the *Macaca mulatta* in Dangan Island and the original golden bamboo forest in Zhuzhou Island.
- *Pseudosciaena crocea* Fry Preserve. It located in the coastal waters, with a depth less than 20 m, around Shantou City, Kaiping County, Shangcuan Island, Xiacuan Island and Zhanjiang City
- Nan'ao Island Nature Preserve
- Fish Fry and Small Shrimp Preserve. It located in the shallow waters from Xuwen County to Nan'au Island with a depth less than 20 meters.
- Zhanjiang Mangrove Preserve and Shenzhen Mangrove & Bird Preserve.

#### *Guangxi Region*

- Shatian Coastal *Dugong* Preserve, with 120 Km<sup>2</sup> of areas, located in the coastal waters of south Shatian, Hepu County where is teeming with *Halodule uninervis* and *Halophila ovalis* that is major food for *Dugong*.
- The Preserve for *Maragyropsedita Tanaka* Fry and Small Shrimp, located in the waters from north Weizhou Island to Haikang County.
- Hepu Pearl Shellfish Preserve.



### ***Hainan Province***

- Lingao White-butterfly Shellfish Preserve
- Wenchang *Eucheuma okamurai* Preserve
- Dongzai Port Mangrove Preserve
- Sanya Coral Reefs Preserve, with area of 4,000 ha; the protection objects are coral reef ecological systems
- Shaodong Island *Sula sula* Preserve, with the area of 180 ha. Xisha Island, with typical tropic seaside, island ecosystems, well-growing tropic coral reefs and tropic reef-island forest, is the sole reproduction area for *Sula sula* in China; besides, there exists green turtle sea cucumber and other precious sea products.

#### **(2) Making laws and regulations on marine environment protection**

In China, a whole set of laws and regulations has been made in which the “Marine Environmental Protection Law of the People’s Republic of China” is an important law to prevent the sea from pollution. The principal contents of the law is as follows:

- 1) To prevent the marine environment from ship pollution;
- 2) To protect the marine environment from damage caused by marine petroleum exploitation;
- 3) To prevent the marine environment from sea dumping;
- 4) To protect the marine environment from contaminants discharging from inland; and
- 5) To protect the marine environment from harming caused by coastal engineering.

Other laws and regulations on marine environment protection are listed in section 6.1.

#### **(3) Tightening up marine environment management and land-based pollution sources**

This includes: drawing up the “Trans-century’s Green Project Plan of China” and “The Biodiversity Protection Action Plan of China”; determining environmental functions of coastal waters; strengthening treatment of wastes from land-based sources; and carrying out the regulation of total pollution load control.

## **2.4 Modification of Aquatic Habitats**

### **2.4.1 Freshwater**

#### ***2.4.1.1 Freshwater Wetlands and Species***

The freshwater wetlands in China coastal areas bordering SCS fragmentarily distribute in the mud flats along with rivers, the dominant species in wetlands are freshwater benthos, fish, shrimp and aquatic plants such as *Phragmites communis*, *Cyperus malaccensis rarbrevifolins* and *Alternanthera philoxeroides*.

A few wetlands distribute also beside the large and middle-sized reservoirs.

According to statistical data, in 1996 the freshwater aquaculture areas in Guangdong, Hainan and Guangxi were 350.8 thousand hectares, 42.2 thousand hectares, and 151.8 thousand hectares respectively. The data of freshwater areas and cultivable areas in two provinces is seen in Table 2.13.

**Table 2.13 Freshwater areas and cultivable areas (in year 1982)**

| Region    | Total area (thousand hectares) |       |       |           |        | Cultivable area (thousand hectares) |       |       |           |        |
|-----------|--------------------------------|-------|-------|-----------|--------|-------------------------------------|-------|-------|-----------|--------|
|           | Total                          | Ponds | Lakes | Reservoir | Rivers | Total                               | Ponds | Lakes | Reservoir | Rivers |
| Guangdong | 680                            | 80    | 0     | 200       | 400    | 287.5                               | 80.8  | 0     | 20        | 6.7    |
| Guangxi   | 466.7                          | 31.3  | 0     | 110.7     | 324.7  | 136.1                               | 28.5  | 0     | 105.7     | 1.9    |

Note: The data of Guangdong Province include that of Hainan Province

Above mentioned data shows that freshwater aquaculture areas in 1996 are more than that in 1982. This indicates that freshwater aquaculture areas are fully utilized already in the regions.

#### **2.4.1.2 River Habitats Modification and Causes**

River habitat modification is very striking. It is shown that river waters are polluted severely and turbidity rises in recent years. The causes are as follows:

##### **(1) Denudation and unreasonable hilly area agriculture**

Denudation, reclamation of fields on the hills and improper farming methods has led to silt content increase of rivers and reservoir siltation. From 1985 to 1989, 27.526 thousand hectares of forest were in whole nation were destroyed and converted as agriculture use while the areas of forest destroy went up to 440 thousand hectares in 1993 from 7.898 thousand hectares in 1990.

Moreover, mining also caused severe soil erosion.

##### **(2) Water pollution and eutrophication**

Municipal sewage, industrial wastewater and surface runoff with chemical fertilizer and pesticide are discharged into water bodies and pollute severely freshwater and riverside mudflats.

Besides, Guangdong is an acid rain area, the precipitation with lower pH value can decrease pH of freshwater and dissolve metal ions from soil such as aluminum ion which is harmful to living aquatic resources when it inter into water body together with surface runoff.

#### **2.4.1.3 Impacts of Global Change**

Global climate warming-up causes a series of natural calamities, such as flood and drought and so on, and brings on negative influence on water bodies and wetlands.

#### **2.4.1.4 Countermeasures**

##### **(1) Afforestation**

In order to recover the destroyed or degraded forest ecosystem, all provinces /autonomous regions have made great efforts to cover the barren mountains with trees. For example, all barren mountains in Guangdong province have been covered with trees. Moreover, the shelf-forest project for Pearl River has started from 1996.

##### **(2) Making laws and regulations on protection of aquatic resources and water bodies**

“The Regulations on Reproduction of Living Aquatic Resources”, “The Law on Water Pollution Control”, etc.

**(3) Making laws and regulations for nature conservation**

- Forest Law of People's Republic of China (1984)
- Mineral Resources Law of People's Republic of China (1984)
- Land Management Law of People's Republic of China (1984)
- Law on Water and Soil Conservation of People's Republic of China (1991)

**(4) Strengthening wastewater treatment and strictly control sewage discharging into rivers.**

**2.4.2 Marine**

**2.4.2.1 Estuaries and Embayments**

**(1) Distribution**

The estuaries and embayments in South China coastal area mainly distribute in following regions:

***Guandong Province***

Han River Mouth, Pearl Estuary, Moyang River Mouth, Daya Bay, Hailingshan Bay, Zhanjiang Bay and Leizhou Bay.

***Hainan Province***

Nandu River Mouth, Changhua River Mouth, Haikou Bay, Qinglan Port Bay and Yangpu Bay.

***Guangxi Autonomous Region***

Beilun Mouth, Tieshan Port Bay, Qingzhou Bay, Fangcheng Bay and Pearl Port.

**(2) Living resources species in estuaries and embayments**

In Pearl Estuary, one of three major estuaries of China, there are 224 species of phytoplankton, 133 species of zooplankton, 456 species of benthos, 185 species of tidal zone organisms. The ecological style in the estuary mainly consists of tropic and subtropic species, and plankton mainly belongs to warm-water species. The vegetation on riverbank is herbosa, such as *Cyperus malaccensis varbrevifolins*, *Phragmites communis* and mangroves with Group of *Bruguiera* and Group of *Kandelia*.

Large tracts of mangroves and shoals extensively distribute in Beilun Estuary with boulder significance. The estuary is a principal area for fish, shrimp, crab and algae to grow, reproduce, migrate and roost.

**(3) Causes of habitats modification**

In past tens years the habitats of estuaries and embayments bordering SCS have modified violently: the wetlands areas narrowed, the nature situation of estuaries and embayments disappeared, the water bodies were polluted due to radical human activities and water pollution. The causes are as follows:



- **Reclaiming land from the sea**

19.6 thousand hectares of shoals have been reclaimed in Pearl River Delta of Guangdong Province, especially in Doumen, Panyu, Zhongshan and other coastal cities or counties with more shoals. Some reclamation actions with 14 thousand hectares of shoals in total to be occupied are being carried out or to be at Modaumen, Yamen and west Lingdingyang.

- **Embayments development**

Recently, heat power plants, ports, docks, tourism regions and economic development areas increases sharply in coastal area, for instance, Daya Bay Nuclear Power Plant, Mawan Power Plant of Shenzhen City and Hailin Island Development District of Yangjiang City, etc. These projects caused habitats decreased and made their ecological functions degraded.

- **Marine aquaculture**

Before 1960's China marine product industry mainly depended on marine fishing, took the first place in. Since 1960's marine aquaculture has played a more and more important role. In early 1980's aquaculture yield took 14% -- 15% of total marine yield while in 1995 the percentage went up to 28.6%. With development of marine aquaculture the remarkable economic benefit has been achieved. At the same time the water body has been polluted partly.

The marine aquaculture area of three provinces (region) is shown in Table 2.14.

**Table 2.14 Marine aquaculture areas**

| Regions   | In year 1980 (ha) | In year 1996 (ha) | Increase rate (%) |
|-----------|-------------------|-------------------|-------------------|
| Guangdong | 21,540            | 138,520           | 543               |
| Hainan    | 680               | 7,594             | 1,017             |
| Guangxi   | 1600              | 48,400            | 2,925             |
| Total     | 23,820            | 194,514           |                   |

- **Water pollution**

Water pollution brings evident impact on fish migration, sea culture, growing and reproduction of fish fry and young shrimp living in the estuaries.

**(4) Countermeasures**

Many natural preserves are set up. To protect the most sensitive areas in embayments according to law. The names of natural preserves have been listed in Section 2.3.2.7 (1). Establishment of these preserves has effectively protected marine ecological environment as well as marine resources.

#### **2.4.2.2 Coral Reefs**

In China the coral reefs ecosystems exist only in SCS. Flourishing coral reefs are the suitable place for reef-roosting organisms to live, to hide and to grow.

China is rich in species of hermatypic coral (see Table 2.15). Non-hermatypic coral has 21 genera, over 40 species. The distribution of hermatypic coral in the SCS can also be seen in Fig. 2.11.

**Table 2.15 Species of recorded hermatypic coral in China**

| Region              | Number of genera | Number of species and sub-species |
|---------------------|------------------|-----------------------------------|
| Nansha Islands      | 33               | 94                                |
| Dongsha Islands     | 27               | 70                                |
| Xisha Islands       | 38               | 127                               |
| Huangyan Island     | 19               | 46                                |
| Taiwan              | 58               | 230                               |
| Hainan Province     | 34               | 110                               |
| Hong Kong           | 21               | 50                                |
| Guangdong & Guangxi | 21               | 45                                |
| Fujian Province     |                  | >10                               |

In China most coral reef resources distribute along the seaside of Hainan Province, one fourth of its seaside (about 400Km) has reefs. There are abundant living marine resources in reef areas such as 81 species of algae, 42 species of *Coelenterat*, 15 species of *Annelida*, 186 species of *Mollusca*, 104 species of *Arthropoda*, 34 species of *Echinodermate*, 27 species of *Pisces*. The areas of coral reefs in coastal regions are seen in Table 2.16.

**Table 2.16 Coral reefs**

| Regions                 | Current total areas (Km2)      | Vanished areas/year | Total species of hermatypic coral | Amount of related species (fish, algae, <i>Mollusca</i> , vertebrate and other invertebrate)  |      |
|-------------------------|--------------------------------|---------------------|-----------------------------------|---|------|
|                         |                                |                     |                                   |   |      |
| Dongsha Island          | 96 – 300                       | N/D                 | 70                                | N/D   |      |
| Hainan Province         | 400 Km Length                  | N/D                 | 110                               | <i>Coelenterata</i>   | 42   |
|                         |                                |                     |                                   | <i>Annelida</i>   | 15   |
|                         |                                |                     |                                   | <i>Mollusca</i>   | 186  |
|                         |                                |                     |                                   | <i>Arthropoda</i>   | 15   |
|                         |                                |                     |                                   | <i>Echinodermata</i>  | 34   |
|                         |                                |                     |                                   | <i>Algae</i>  | 81   |
|                         |                                |                     |                                   | <i>Pisces</i>   | 27   |
|                         |                                |                     |                                   | Corpus cavernosum   | 1    |
|                         |                                |                     |                                   | Platyl mimthes  | 1    |
| Zhongsha Island         | 139 Km Length, 61 meters width | N/D                 | 46                                | <i>Pisces</i>   | >300 |
|                         |                                |                     |                                   | Sea cucumber, lobster, turtles, hawksbill, etc.   |      |
| Nansha Island           | N/D                            | N/D                 | 94                                | Crabs   | 73   |
|                         |                                |                     |                                   | <i>Mollusca</i>   | 180  |
|                         |                                |                     |                                   | <i>Pisces</i>   | 195  |
| Xisha Island            | N/D                            | N/D                 | 127                               | N/D   |      |
| Zenmuansha              | 2.2                            | N/D                 | 6 SP of soft coral                | Drifting fish roe / fry   | 61   |
|                         |                                |                     |                                   | Algae   | 3    |
|                         |                                |                     |                                   | <i>Polychaeta</i>   | 11   |
|                         |                                |                     |                                   | <i>Mollusca</i>   | 47   |
|                         |                                |                     |                                   | <i>Crustacea</i>  | 40   |
|                         |                                |                     |                                   | <i>Echinodermata</i>  | 16   |
| Guangxi(Weizhou Island) | >5.15                          | N/D                 | 45                                | One species of fish, some species of jellyfish, <i>Mollusca</i> , <i>Hydrozoa</i> , <i>Asteroidea</i> , <i>Echinoidea</i> and Varians <i>Mallusca</i> |      |
| Huangya Island          | 150                            | N/D                 | 46                                | N/D   |      |
| Taiwan                  | N/D                            | N/D                 | 230                               | N/D   |      |
| Hong Kong               | N/D                            | N/D                 | 50                                | N/D   |      |
| Fujian Province         | N/D                            | N/D                 | >10                               | N/D   |      |
| Total                   | N/D                            | N/D                 | 200                               | N/D   |      |

- **Damage caused by human activities**

In some places, such as in Sanya of Hainan Province, coral reefs were quarried as building material; coral hydranth was taken for tourism souvenir and so on; as a result, this resource has been destroyed severely, the reefs distributing in seaside of Hainan has decreased by 95%.

- **Impacts of global change**

During the recent years, albino of coral reefs caused by greenhouse effect has been paid close attention in whole world as well as in China.

- **Countermeasures**

Setting up preserves to manage and protect coral reefs by operation of law. The nature preserves for coral reefs in China are as follows:

- 1) Beijian Nature Preserve, Shaodong Island, Hainan Province
- 2) Yongshu Nature Preserve, Nansha Islands. Yongshu reefs are typical tropic coral atoll with nearly 100 species of coral polyps
- 3) Sanya Nature Preserve, Hainan Province
- 4) Lingao Point Nature Preserve, Lingao County, Hainan Province, with an area of 3,457 ha
- 5) Lingao County Coral Reefs Nature Preserve, Hainan Province, with an area of 32,400 ha
- 6) Dadonghai Coral Reefs Nature Preserve, Sanya City, Hainan Province, with an area of 13.45 ha
- 7) Linqiangshi Island Coral Reefs Nature Preserve, Danzhou City, Hainan Province, with an area of 131 ha
- 8) Weizhou Island and Xieyang Island and near waters Preserve, Beibu Gulf, Guangxi Zhuang Autonomous Region, which is a transitional area from tropical zone to subtropical one.

#### 2.4.2.3 *Mangroves*

- **Change in area and species composition**

In China mangroves naturally distribute in some coastal provinces / regions: Guangdong, Hainan, Guangxi, Fujian, Taiwan, Hong Kong and Macao. Guangdong, Hainan and Guangxi are the major distribution areas, among them Hainan has the most widespread distribution of mangroves along coast.

Nowadays, large tracts of mangroves with areas more than 667 ha can only be found in four places: Dongzai Port of Hainan Province, Qinglan Port of Hainan Province, Tongminghai in Zhanjiang City of Guangdong Province and Malanji Port in Fangcheng City of Guangxi Autonomous Region. The two ports of Hainan Province aforementioned are the places with the largest areas and richest species of the tree and also the principal mangroves regions of China.

There were 420,010 thousand hectares of mangroves in the country in early 1950's. But at present, the areas have sharply fallen to 148,690 thousand hectares, with a decrease of 65%. Meanwhile, part of tree has degraded to half mangroves or secondary sparse woods. The species and distribution areas of mangroves are listed in Table 2.17 to Table 2.20.



**Table 2.17 Species and distribution of mangroves in China**

| Family name    | Species name                          | Provinces / Regions |      |       |           |         |        |        |
|----------------|---------------------------------------|---------------------|------|-------|-----------|---------|--------|--------|
|                |                                       | Hainan              | H.K. | Macao | Guangdong | Guangxi | Taiwan | Fujian |
| Rhizophoraceae | 1. <i>Bruguiera cylindrica</i>        | +                   |      |       |           |         |        |        |
|                | 2. <i>B. Bymnorrhiza</i>              | +                   | +    |       | +         | +       | +      | +      |
|                | 3. <i>B. Sexangula</i>                | +                   |      |       |           |         |        |        |
|                | 4. <i>B.s. var. rhynchopetala</i>     | +                   |      |       |           |         |        |        |
|                | 5. <i>Ceriops tabal</i>               | +                   | +    |       | +         | +       | +      |        |
|                | 6. <i>Kandelia candel</i>             | +                   | +    | +     | +         | +       | +      | +      |
|                | 7. <i>Rhizophora apiculata</i>        | +                   |      |       |           |         |        |        |
|                | 8. <i>R. stylosa</i>                  | +                   | +    |       | +         | +       |        |        |
|                | 9. <i>R. mucronat</i>                 |                     |      |       |           |         | +      |        |
| Canthaceae     | 10. <i>Acanthus ebracteatus</i>       | +                   |      |       | +         |         |        |        |
|                | 11. <i>A. ilicifolius</i>             | +                   | +    | +     | +         | +       | +      | +      |
|                | 12. <i>A. xiamenensis</i>             |                     |      |       |           |         |        | +      |
| Amingtoniaceae | 13. <i>Bamingtonia racemosa</i>       | +                   |      |       |           |         |        |        |
| Ombretaceae    | 14. <i>Lumnitzera littorea</i>        | +                   |      |       |           |         |        |        |
|                | 15. <i>L. Racemosa</i>                | +                   | +    |       | +         | +       | +      |        |
| Uphorgiaceae   | 16. <i>Excoecaria Agallocha</i>       | +                   | +    |       | +         | +       | +      | +      |
| Eliaceae       | 17. <i>Xylocarpus granatum</i>        | +                   |      |       |           |         |        |        |
| Almae          | 18. <i>Aegiceras comiculatum</i>      | +                   | +    | +     | +         | +       | +      | +      |
| Ubiaceae       | 19. <i>Nypa fruticans</i>             | +                   |      |       |           |         |        |        |
| Almae          | 20. <i>Scyphiphora hydrophyllacea</i> | +                   |      |       |           |         |        |        |
| Innedatuaceae  | 21. <i>Sonneratia alba</i>            | +                   |      |       |           |         |        |        |
|                | 22. <i>S. caseolaris</i>              | +                   |      |       |           |         |        |        |
|                | 23. <i>S. hainannensis</i>            | +                   |      |       |           |         |        |        |
|                | 24. <i>S. ovata</i>                   | +                   |      |       |           |         |        |        |
| Tercykuaeeae   | 25. <i>Heritiera littoralis</i>       | +                   |      |       |           |         |        |        |
| Erbernaceae    | 26. <i>Avicennia marina</i>           | +                   | +    | +     | +         | +       | +      | +      |
| Total          |                                       | 24                  | 9    | 4     | 10        | 9       | 9      | 7      |

**Table 2.18 Species and distribution of half-mangroves in China**

| Family name       | Species name                     | subregion |      |       |           |         |
|-------------------|----------------------------------|-----------|------|-------|-----------|---------|
|                   |                                  | Hainan    | H.K. | Macau | Guangdong | Guangxi |
| 1. Acrostichaceae | 1. <i>Acrostichum aereum</i>     | +         | +    | +     | +         | +       |
|                   | 2. <i>A. speciosum</i>           | +         |      | +     | +         |         |
| 2. Apocynaceae    | 3. <i>Cerbera manghas</i>        | +         |      |       |           |         |
| 3. Bignoniaceae   | 4. <i>Dolichandron spathacea</i> | +         |      |       | +         |         |
| 4. Compositae     | 5. <i>Pluchea indica</i>         | +         |      |       | +         |         |
| 5. Hemandiceae    | 6. <i>Hemadia sorona</i>         | +         |      |       |           |         |
| 6. Leguminosae    | 7. <i>Pongamia pinnata</i>       | +         |      |       | +         |         |
| 7. Lythraceae     | 8. <i>Pephis acidula</i>         | +         |      |       |           |         |
| 8. Malvaceae      | 9. <i>Hibiscus tilisceus</i>     | +         | +    |       | +         | +       |
|                   | 10. <i>Thespesia populnea</i>    | +         |      |       | +         | +       |
| 9. Verbenaceae    | 11. <i>Premna obtusifolia</i>    | +         |      |       | +         | +       |
| Total             |                                  | 11        | 2    | 1     | 2         | 5       |

**Table 2.19 Common accompanying plant of mangrove**

|                  | Species name  |
|------------------|---|
| Woody plant      | <i>Clerodendron inerme</i><br><i>Myoporum bontioides</i><br><i>Scaeola sericea</i><br><i>Shainanensis</i><br><i>Scolopia chinensis</i><br><i>Crateva religiosa</i><br><i>Calophyllum inophyllum</i>         |
| Vine or epiphyte | <i>Denis trifoliata</i><br><i>Hoya camosa</i><br><i>Dischidia chinensis</i><br><i>Flagellaria indica</i><br><i>Lygodium sp.</i>   |
| Herb             | <i>Cynodon dactylon</i><br><i>Zoisa matrella</i><br><i>Sporobolus virginicus</i><br><i>Paspalum distichum</i><br><i>Phragmites communis</i><br><i>Cyclosorus intenus</i><br><i>Pityrogramma calomelanos</i> |

**Table 2.20 Mangrove species and distribution in China**

| Name of province /region | Mangrove areas (ha) |         |               | Number of mangrove species |               |       |
|--------------------------|---------------------|---------|---------------|----------------------------|---------------|-------|
|                          | In 1950             | In 1990 | Decrease rate | Mangrove                   | Half mangrove | Total |
| Hunan                    | 9,992               | 4,836   | 52%           | 24                         | 11            | 35    |
| Guangdong                | 21,289              | 3,813   | 82%           | 10                         | 8             | 18    |
| Guangxi                  | 10,000              | 5,654   | 43%           | 9                          | 5             | 14    |
| Hong Kong                |                     | 85      |               | 9                          | 2             | 11    |
| Macao                    |                     | 1       |               | 4                          | 1             | 5     |
| Fujian                   | 720                 | 360     | 50%           | 7                          | 2             | 9     |
| Taiwan                   |                     | 120     |               | 9                          | 8             | 17    |
| Total                    | 42,001              | 14,869  | 65%           |                            |               |       |

***The related species in mangroves (fish, bird and others)***

A number of living organisms including hundreds of species of bird, tens of species of fish and many species of invertebrate live in mangrove ecosystems of the SCS. For instance, in Zhanjiang mangrove preserve, Guangdong Province, there are 73 species of bird including 37 species of resident and 36 species of migrant, 26 species of zooplankton, 111 species of benthos and 133 species of Insects. Moreover, various organisms stay in Shenzhen Futian mangrove preserve, such as nearly 40,000 birds, belonging to 112 species, including *Egretta jarzeta* *Ardeota bacchus* and *Bubulcus*; 36 species of ordinary marine invertebrate, including 18 species of *lame llibranchiata* 9 species of *Gastrooda* and 9 species of *Crustacea*. In Dongzhai port mangrove preserve, the representative of mangrove ecosystems in Hainan Province, there exist 118 species of bird, 4 species of beast, 8 species of fish and 85 species of other aquatic animal. Change of distribution areas of mangrove in recent years in coastal regions and composition of mangrove-related species are shown in Table 2.21.