Global Water Partnership (China) WACDEP
Work Package Five outcome report

Pearl River Delta Demonstration Project

Pearl River Water Resources Research Institution
December 201

Preface

The Pearl River Delta (PRD) is the low-lying area surrounding the Pearl River estuary where the Pearl River flows into the South China Sea. It is one of the most densely urbanized regions in the world and one of the main hubs of China's economic growth.

This region is often considered an emerging megacity. The PRD is a megalopolis, with future development into a single mega metropolitan area, yet itself is at the southern end of a larger megalopolis running along the southern coast of China, which include Hong Kong, Macau and large metropolises like Chaoshan, Zhangzhou-Xiamen, Quanzhou-Putian, and Fuzhou. It is also a region which was opened up to commerce and foreign investment in 1978 by the central government of the People's Republic of China.

The Pearl River Delta economic area is the main exporter and importer of all the great regions of China, and can even be regarded as an economic power. In 2002, exports from the Delta to regions other than Hong Kong, Macau and continental China reached USD 160 billion.

The Pearl River Delta, despite accounting for just 0.5 percent of the total Chinese territory and having just 5 percent of its population, generates 20 percent of the country's GDP.

The population of the Pearl River Delta, now estimated at 50 million people, is expected to grow to 75 million within a decade.

The demonstration program in the Pearl River Delta plans to be implemented from January 2014 to December 2015 and further evaluate the results from January to December 2016, practicing the approach of cross-sectors cooperation; trans-boundary cooperation; and management of urbanization with the urbanization rate of over 70% and development of ecological regulation by green solution. Under the particular targets, the package five designs its tools/tactics step-by-step annually working towards the outputs. The end of 2014 meets the annual results of the demonstration program through our designed tactics, including, identifying the problems of the demonstration Program regarding water and climate change; and developing countermeasures, strategies and solution tools and etc.

Content

I. Background

1.1 Geographic Characteristics of Pearl River Delta

Pearl River DeltaBasin is formed by West River(West River), North River(North River), Dongjiang (East River) and the Pearl River. These four elements cover the area of 453 700 km^2, of which 442 100 km^2 in the territory of the P.R. China.

Figure 1.Distribution of Pearl River Basin in China

1.2 Social and Economic Characteristic of Pearl River Delta

Pearl River Delta and its estuary cover Guangdong, Hong Kong and Macao. In the region, the urbanization rate is high and the population is large. And its industrial, social, economic and political developments are significant in China.

Guangdong Province is located in the south, facing the South China Sea since ancient times. This is an important trading port of China's foreign trade. Nearly 30 years, as the forefront of China's reform and opening up, this province plays a prominent role in the national development strategy and the overall economic and social reform and opening up. Nine cities, including Guangzhou, Shenzhen, Foshan, Dongguan, Zhongshan, Zhuhai, Huizhou, Jiangmen and Zhaoqing, form an important circle in the Pearl River Delta region in mainland China, with a top scale of economy and population density. According to 2011 statistics, the region's GDP is of nine cities

reached 4.4 trillion RMB, accounting for 83.47 percent of national GDP. By the end of 2012, the resident population of the Pearl River Delta regions about 56,163,900, accounting for 53.71 percent of Guangdong Province, and its land area is 24,437 km^2, which is less than 14% of Guangdong Province, the population is thus highly concentrated.

Hong Kong is located in the east of the Pearl River estuary, facing Shenzhen City of Guangdong Province cross Shenzhen River. Known as the "Pearl of the Orient" in the world, Hong Kong is a world renowned international metropolis and the world's third largest financial center next to London and New York. It is also jointly utilized with the New York and London, called "Nuremberg harbor." According to statistics, Hong Kong has a population of 7.13 million (2012), with a total area of 1070 square kilometers, which is one of the world's most densely populated areas; in 2011 the GDP in Hong Kong was 1.89 trillion HKD, GDP per capita was 34,457 USD.
Macau is located in the south of Zhuhai City of Guangdong Province, looking East to Hong Kong across the sea in a distance of 60 km. Macau population density is 1.89 people/km^2 (in April 2011, the sixth national census data), ranked first in the world; GDP per capita was 74,228 USD (2012), ranked fifth in the world.

1.3 Hydrological Characterizes of Pearl Delta

Pearl River Delta is complex in river network with catchment area of 26,800 km^2, accounting for 5.91 percent of the Pearl River Basin area. In addition, small rivers flowing into the Pearl River Delta are Tan River flow, Liuxi River, Zeng River, Sha River, Gaoming River and Shenzhen River.

The Pearl River estuary flows east from Kowloon City in Kowloon Peninsula and west to Chixi Peninsula, with over 450 km coastline in the mainland China. The Estuary has built up eight gates, each of which has same dynamic characteristics and different in flood and tide control capacity. (See Figure 2)

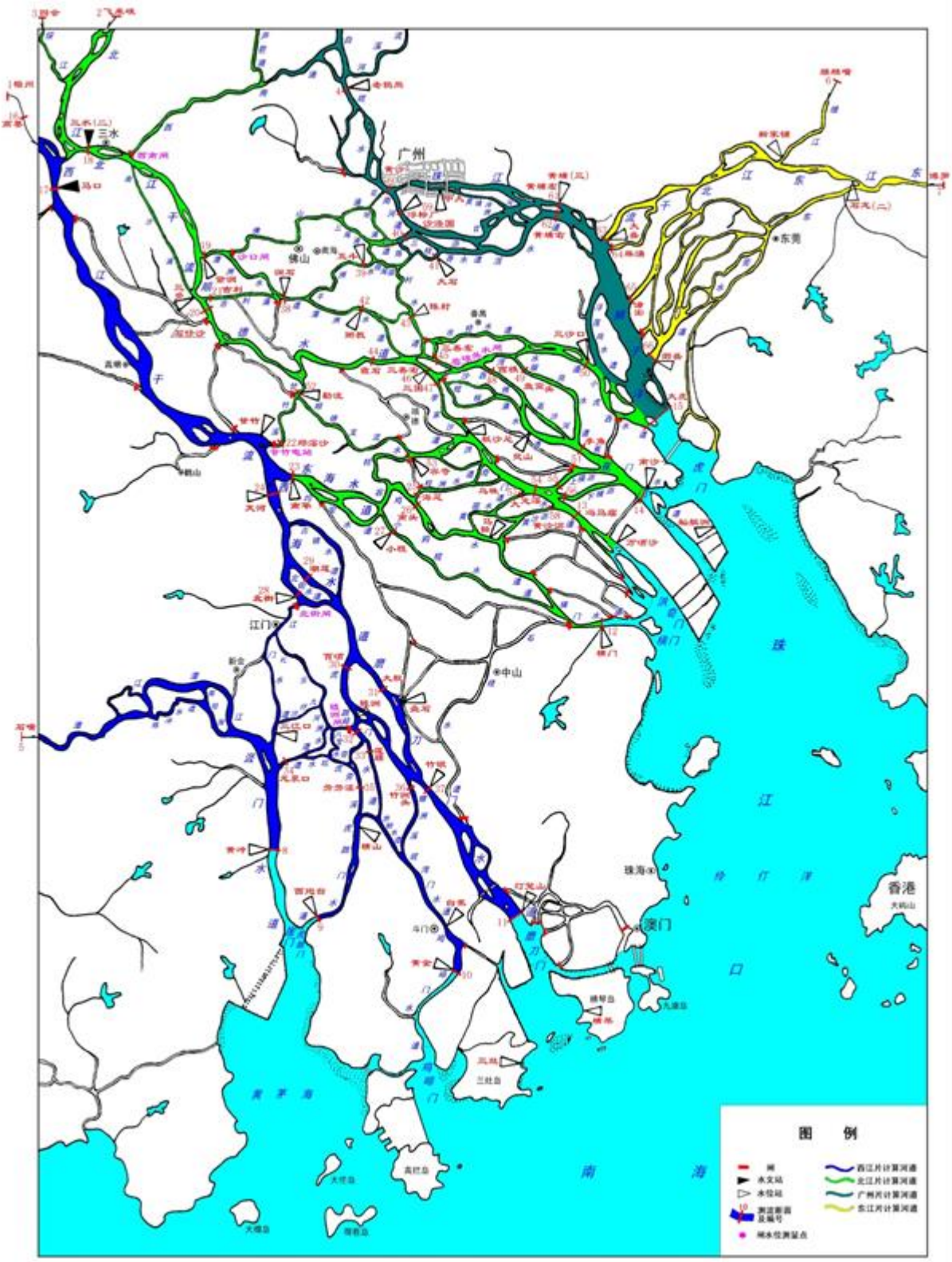


Figure 2 Runoff of the Pearl River Delta

The Pearl River has features of "confluence of three rivers, dense river network, eight stations at the Estuary next to sea, the whole interactive". It is one of the most

complex rivers in the world in terms of water system structure, dynamic characteristics and human behaviors.

1.3.1 Rainfall

Pearl River Basin is mild and rainy with average annual rainfall of 1771mm. Its rainfall season is in March to September and its rainfall in flood season accounts for 70% to 80% of annual rainfall with great storm intensity. Rainfall distribution shows a gradual decrease from east to west. The variability is shown in uneven distribution of rainfall in years and in regions. (See figure 2)

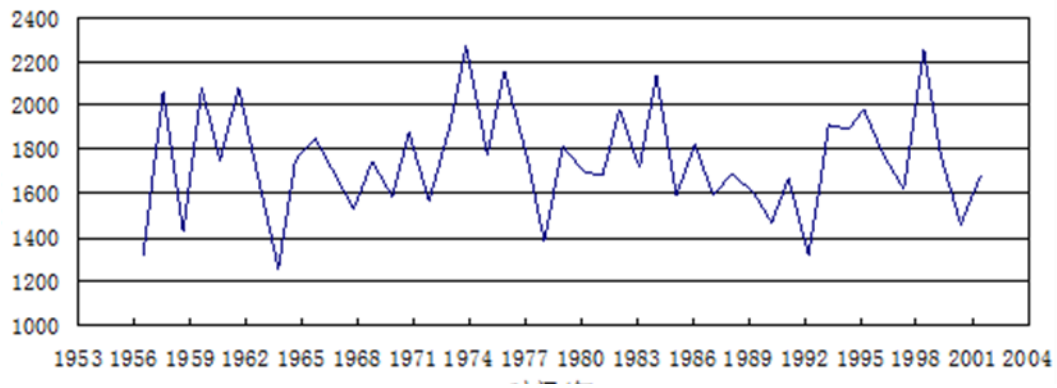


Figure 3 Pearl River Rainfallsbetween1956-2004

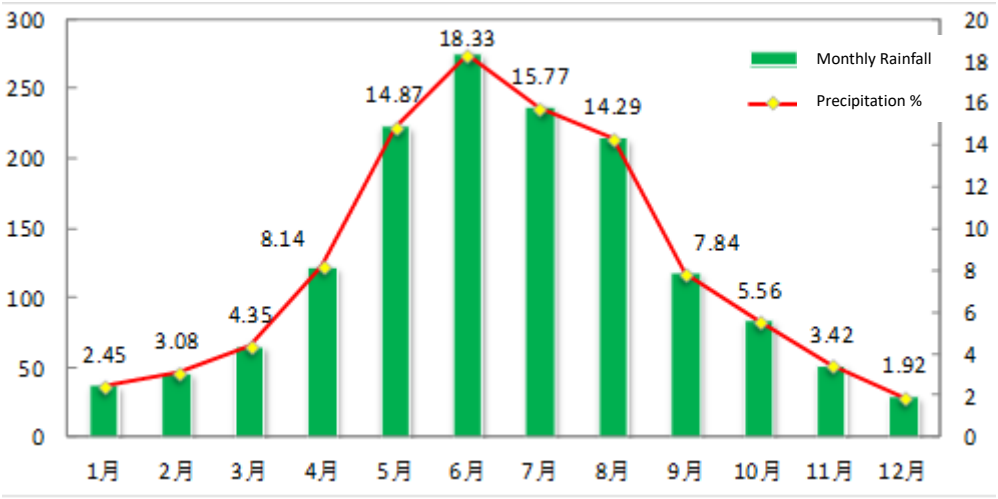


Figure 4 Distribution of precipitation in the Pearl River Basin during a year

In the estuary, the average annual rainfall is between 1600 ~ 2100mm and the precipitation in different areas is slightly different, of which, the precipitation in coastal area is higher than that in non-coastal areas. The flood season is in April to September, accounting for 81% to 85% of total annual rainfall. And typhoons, storms and thunderstorms are in July to September. The annual number of days of precipitation is 145 ~ 151days, accounting for about 40% of a year. A large part of year is rainy days, of which the storm days with precipitation of 150mm/d are 0.3 ~

0.6days. The total annual rainfall is up to 2250 ~ 2850mm, the minimum is about 1000mm. The maximum continuous rainfall is 403.6mm, lasting 44h40min (September 27 to 29, 1965 in Shunde County Station). Within 24h, the maximum rainfall was on September 23 to 24, 1979 with the rainfall of about 300mm in the Delta.

1.3.2 Runoff

The flood season starts from April every year, between April and October. Within the Pearl River Basin, the runoff distribution in West River, North River and East River differ slightly. The water inflow of West River is between May and September, accounting for 72.1% of annual runoff of West River. Dry season is between October and March, accounting for 23.5 percent of annual runoff of West River. The flood season of North River is earlier than West River, mainly between April and September, accounting for 76 percent of the annual runoff of North River basin; dry season is between October and March, accounting for 21.2percent of annual runoff of North River. The flood season of East River is also concentrated between April and September, accounting for 70.3percent of annual runoff of East River; in dry season, it is between October and March, accounting for 25.8 percent of annual runoff of East River.

The inflow of North River Basin is in April, May and June, accounting for 47.9 percent of annual water quantity. And June is the peak month of annual water allocation, accounting for 18.2%. The inflows in East River and West River are between June and August, accounting for 40.0% and 50.9% of total quantity, respectively, in a year. June is the peak month of the East River with annual allocation of 16%; and July in West River reaches peak allocation of 18.7%. Thus, in the flood season between June and August, the highest inflow and runoff is in West River, followed by North River and East River.

The dry season of West River in Gaoyao Gate and Makou Gate is January, and that of North River in ShekKok is December, while Sanshui station's dry season is January as West River, The annual dry season monitoring statistics of Makou Station, Sanshui Station and Sixianjiao between 1961 to 2005, totaling 45 years, show average changes towards an increasing trend in varying degrees, while Sanshui Station has the most significant growth, and growth in Makou Station is the least obvious, where as Sixianjiao Station is in the middle level of change.

Table 1shows the monthly average runoff of Makou, Sanshui and Boroovers years, in which, the upstream runoff is between April and September ,in Makou, Sanshui and

Boro accounting for 77%, 85% and 71%respectively in a year.

Station	Jan	Feb	March	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Aver
Makou	2.73	2.88	3.80	7.04	11.98	16.91	16.58	14.37	9.90	6.08	4.64	3.09	100
Sanshui	1.55	1.77	2.83	6.46	12.35	20.46	19.96	15.79	9.62	4.37	3.09	1.76	100
Boro	3.97	4.23	5.29	8.03	11.16	17.73	12.10	12.02	10.43	6.23	4.65	4.16	100

Table 1 Runoff Distribution Ratio (%)

1.3.3 Tide

Pearl River estuary tide has frequent changes every 12 hours, with twice high-water of tides and twice low-water of tides in 24 hours, having high and low spring tides every 15 days. Due to the impact of floods and storm surges, the highest tide level generally is between June and September; and the lowest is between December and February.

The eight stations in the Pearl River Basin have tidal range between 0.85 ~ 1.62m, where the largest tidal range is in Humen Station reaching 3.38m. According to the statistics in the past 20 years, the average mountain tide ratios of eight stations entrance are 0.38 inHumen, 1.79 in Jiaomen, 2.51 in Hongqimen, 3.68 in Hengmen, 6.22 in Modaomen, 1.72 in Jitimen, 3.43 in Hutiaomen and 0.24 in Yamen.

In the stations, flow tide spends longer time than ebb tide does in both flood and dry seasons, which is more obvious in the upstream. And ebb tide in dry season takes longer time than in flood season.

II. Analysis on Current Situation

Global change, global warming and sea level raise the most serious impact on human society. Currently more than half the world's population lives in coastal areas less than 50 km to the sea, the average population density in the coastal areas is 10 times higher than in inland. Studies have shown that if the sea level rises 1m in the next 100 years, it would directly affect land of5 million km^2, 10 million population and about one-third of the world's arable land.

With the development of economy, society, and the Pearl River Delta industrial and

agricultural production and domestic consumption increase. 1980 to 2008, the Pearl River Delta urban water consumption increased by more than 10 times, reaching 19.359 billion m^3annually. It is predicted that the total water consumption of Pearl River Delta region will reach 59 billion $m^3$by 2020, and further up to 960 billion $m^3$by 2030. As human activities also exacerbate global climate change and sea level rise, the supply and demand of freshwater resources in the Pearl River Delta estuary become a prominent conflict. Therefore, it is a serious challenge to flood control, drainage and water supply security.

2.1 Regarding Salt Tides

Due to the climate change, sea level rise and human activities have increased and produced a significant adverse effect on the salt tide in the Pearl River Delta. The salt tide has high intensity, and frequency of occurrence, causing water security in Guangzhou, Zhuhai, Zhongshan, Macao, Hong Kong. Ground million residents have to meet frequent emergency that cause widespread concern of the State Council and the Guangdong, Hong Kong, Macao community.

2.1.1 Current Countermeasures of Salt Tides

2.1.1.1 Engineering Measures

(1) Monitoring of salt tides

Field observations reflect the most authentic salt tide intrusion law and those observation results are also firsthand resources to study the mechanism of salt tide intrusion. Pearl salt tide movement is very complex, having three-dimensional characteristics of apparent density stratified flow, which has traced the course date, half of the cycle and seasonal changes. Back to 2009, the prototype lacked of synchronization, the time series was too short and the course of the dynamic mechanism of the key factors limiting the vertical stratification was not enough, etc., which made it difficult to achieve a complete analysis of salt mixed state of dynamic conversion of freshwater or the vertical circulation, failing the study intrusion rules and mechanisms of salt tide.

To this end, in December 2009, the Pearl River Hydraulic Research Institute in the Pearl River Delta Modao Station conducted a large-scale salt tide prototype observation. Observation period was between 15:00 on December 10 and15:00 on December 25with eight vertical measurements emplaced. They observed salinity, flow, flow direction, wind speed and direction, in which flow rate, flow and salinity every was observed by the vertical measurement in every one meter with 8-12 layers

of vertical stratification obtained hourly data for a period of two weeks. The observations focused on the source of salt tide intrusion of Modao Station, which had the following characteristics: (1) long time observation, reaching 15 days of half tidal cycle; (2) high observation frequency, measured at intervals of one hour for the record; (3) measuring point layout was reasonable, taking into account the Modao Station and Hongwan waterways, covering the main areas of activity of the salt tide Modao Station; (4) large number of vertical stratification, up to 8 to 12 layers. Therefore, this measure had a good representation of the data, both to reflect the half day period tidal cycle variation of salt tide intrusion at Modao Station, but also to reflect the density stratified flow characteristics of vertical power structure, which were data supports to the Pearl River Delta salt tide intrusion rules and mechanism.

In order to build the Pearl River estuary salinity quantitative remote sensing inversion model, it was carried out in January 2010 and December 2011, respectively, in Lingdingyang Station, Modao Station and Huangmaohai station to conduct a wide range of synchronous satellite observation and sampling, including surface water body spectrum salinity, yellow substance absorption coefficient and other parameters.

Through in-depth analysis of the above data, it could reflect factors affecting Modao Station salt tide intrusion through in-depth understanding of day and half-cycle variation of power. Experimental study also provided a good data base to physical models, inversion and the establishment of remote sensing salinity numerical model, playing a vital role in the research progress.

(2) Multi-discipline technical system

By studying a series of research projects for Pearl River complex, the salt tide research technology system was initially built up combining the physical model tests, remote sensing and numerical simulation of salinity inversion.

① physical model test

China has built the first wind, wave and current, salty coupling test tank and the salt tide in the Pearl River estuary of Modao Station physical model, and the formation of a set of advanced salt, tide, wind, wave and current multi-factor coupled synchronization control system.

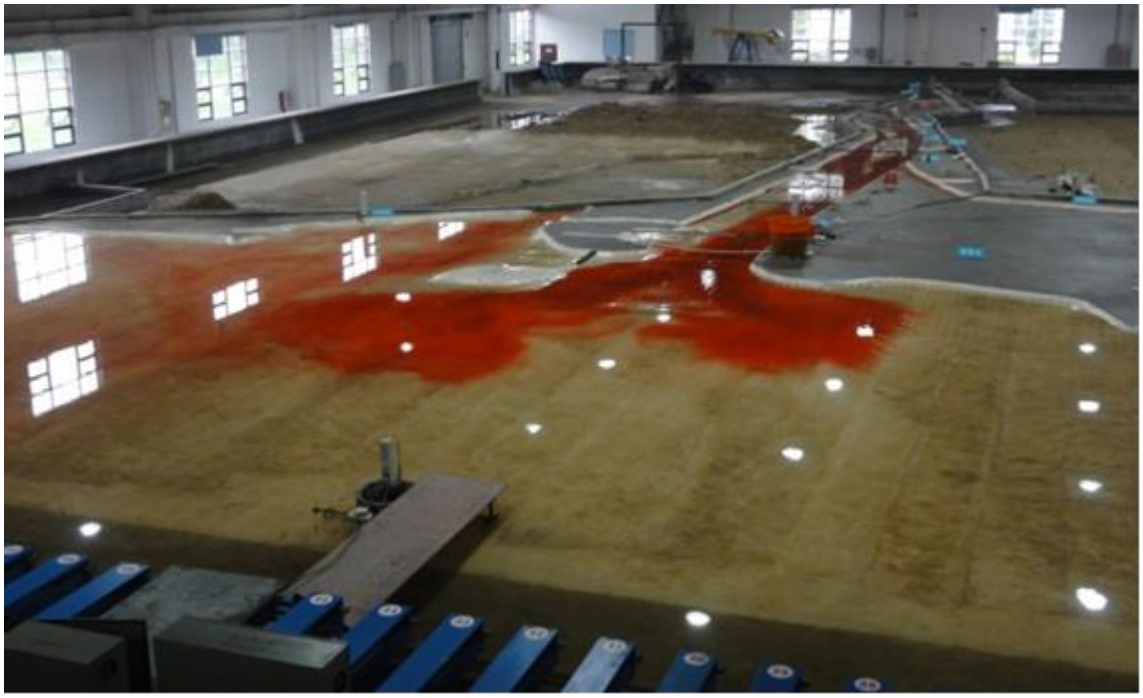


Figure 2.1.1 A.Physical model of salt tides

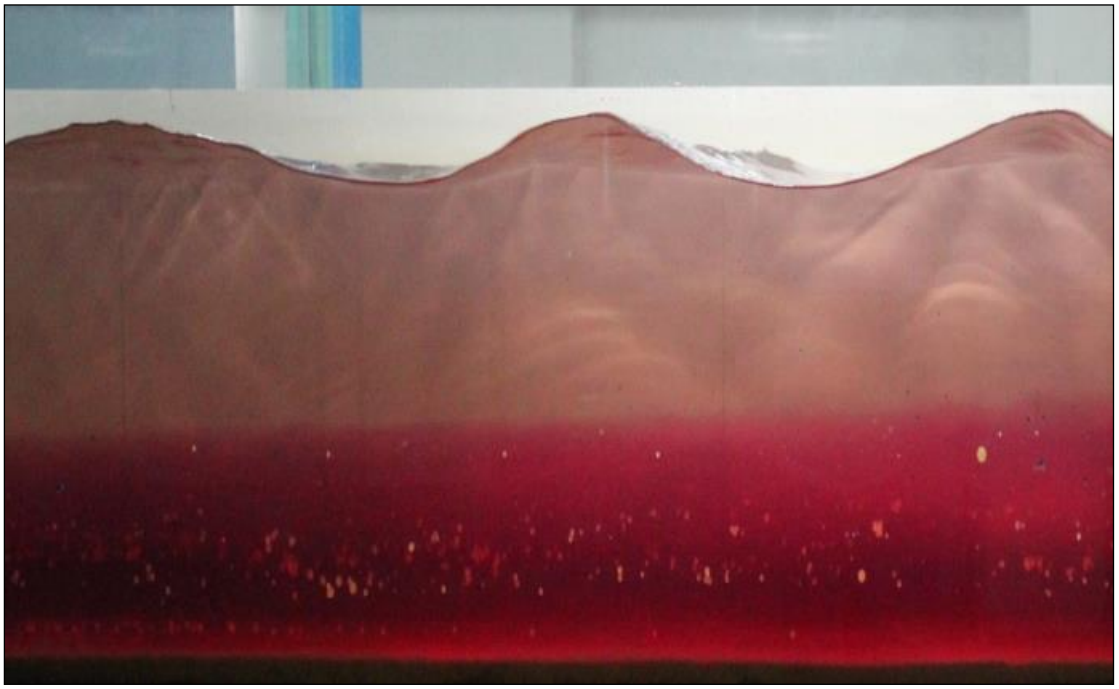


Figure 2.1.1 B Wind, wave and current, salty coupling test tank

② Simulation

Pearl River estuary has typical multi-branching estuaries and all stations in the basin area have similar characteristics. The rivers network in the upstream is complex and crossing each other. Close to estuarine and coastal waters, there are many islands,

shoreline twists, turns and complicated underwater terrain, showing characteristics of obviously density stratified flow. In order to accurately simulate the dynamic process of the Pearl River estuary salt tide intrusion, it constructed a wide range of high-resolution and three-dimensional mathematical model in the Pearl River estuary of baro clinic realized within the river estuary based on high-performance parallel computing algorithms and unstructured triangular grid, to realize a numerical simulation process of three-dimensional density points layer flow force.

Grid computing model shown in Figure 2.1.1 C, covered the entire Pearl River Delta, the main rivers, estuaries and coastal waters. The rivers in the upstream in the model were Shiju, Mazui, Sanshui, Hengkong, Xitang and Si Sheng Hydrological Station, off the coast of the open border to take to the vicinity of about 300m depth contour, etc..The entire calculation range from east to west was about 400km; and was ground 340km from south to north. According bathymetry and shoreline trend Modao Station grid, it made local refinement and optimization of waterways, basins and other waters. The transition from sparse to dense mesh uniform reflected the unstructured triangular mesh arrangement advantage of flexibility. Entire computing grid nodes were up to 166,279 with number of units to 299,439, in which the smallest unit edge length was 40m, maximum element edge length was about 20km and equidistant vertical stratification had 11 layers.

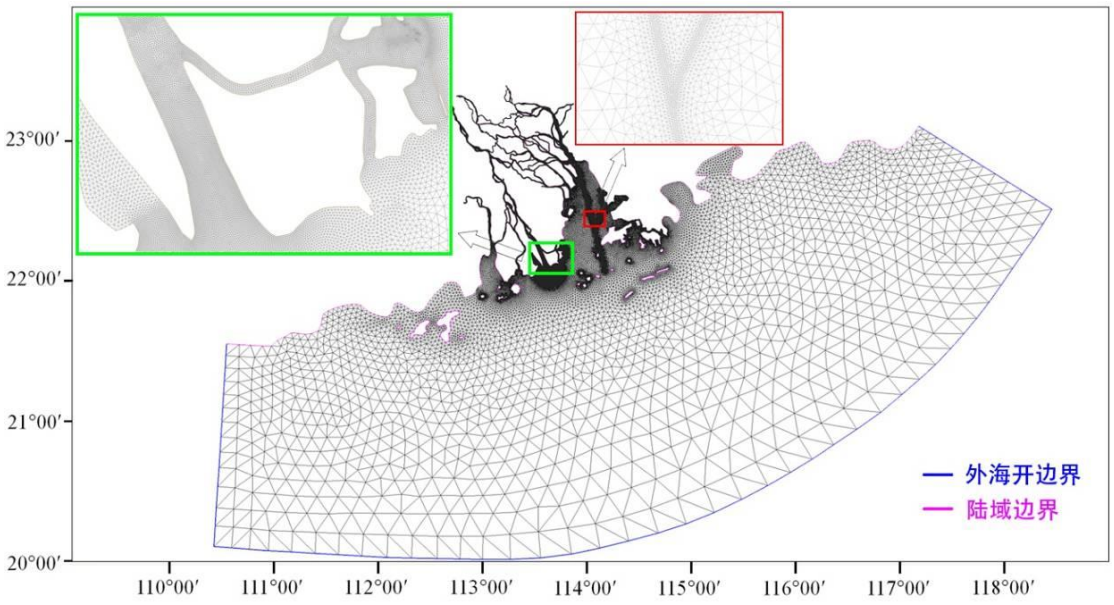
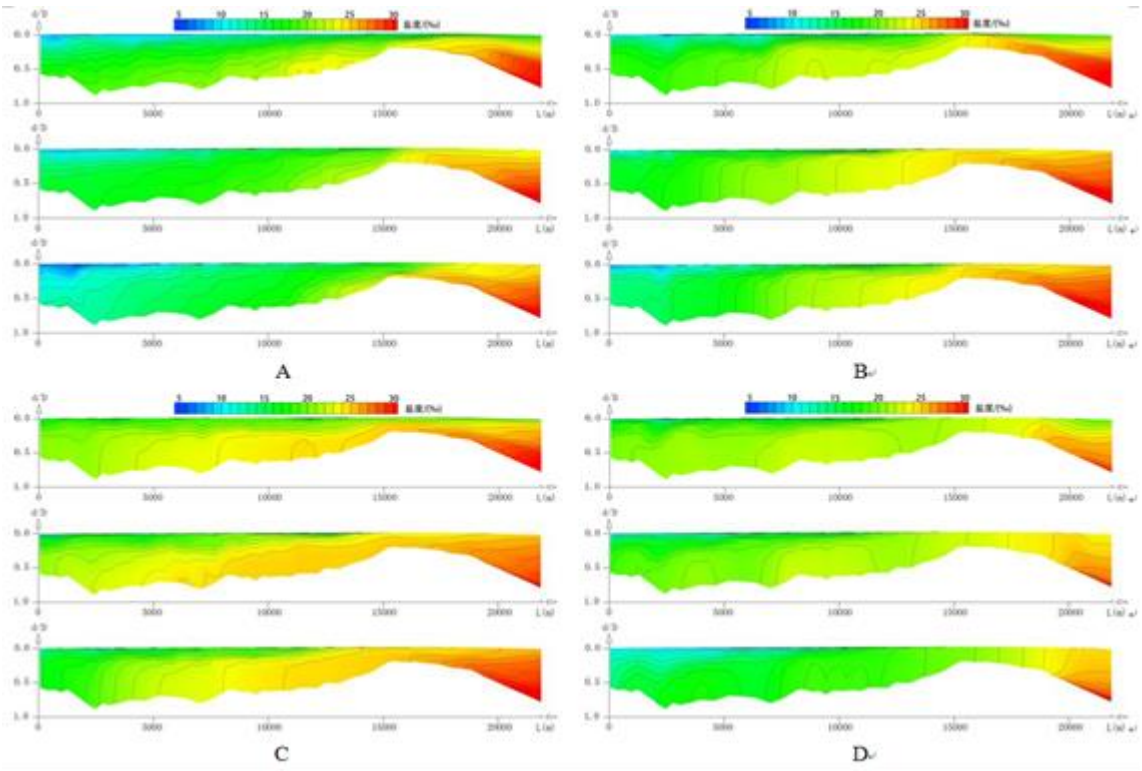


Figure 2.1.1 C PC Network of Model

River flow upstream model boundary conditions were given by measured data; offshore tidal boundary conditions were calculated by the tidal harmonic constants, including M2, S2, N2, K2, K1, P1, O1, Q1, eight major tides. Given that the position of open sea off the boundary was far enough away from the estuary with little influence of the red freshwater, the boundary conditions were quantitative to salinity. In addition, in light of wind influence, the model input also included the daily average wind data.

Model hydrodynamic module built up initial conditions using the "cold start", i.e., the initial value of water level and another initial value of zero velocity. Initial field salinity had greater impact on salty freshwater distribution for its three-dimensional structure for vertical stratification. It was more difficult to develop an accurate initial salinity field. In recent years, the Pearl River Institute of Hydraulic Research used the negative correlation between salinity and yellow substance to construct a surface salinity quantitative remote sensing inversion model. The practical application reflected that it thus obtained with good extract accuracy of the Pearl River estuary confirmed surface salinity values. Therefore, it used satellite remote sensing data inversion surface salinity values, combined with the vertical field data and empirical laws salinity distribution layers of the Pearl River Estuary to make vertical interpolation salinity, calculating the required initial salinity field. Such initial salinity field given was substantially closed to the actual values; salinity reached equilibrium in a relatively short time of model calculations. For insurance purposes, the actual calculation of this article had utilized this model for two months in advance; the results were analyzed after taking stable.



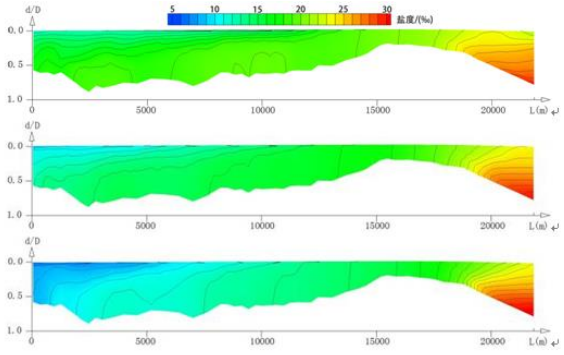


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Figure 2.1.1 D.Section vertical salinity distribution (from top to bottom: low tide, middle tide, high tide)

③ Remote salinity inversion

Prototype observations were single-point data; you cannot get the plane salinity distribution of a wide range of the Pearl River Estuary, to some extent limit the research activities and the dynamic properties of the salt tide in the estuary as a whole. To this end, it constructed surface salinity quantitative remote sensing inversion model on the basis of linear negative correlation from the existing research on the use of salinity and yellow substance.

The technical process is as follows:

a) Data source: using MODIS data, component concentrations ground water data collected fixed-site Salty observation data.

b) Data processing: as the water itself is a weak reflector, its information is more likely to be affected by the atmosphere, as well as equipment and stable platform attitude, etc., so before you want to use remote sensing data processing. The process of treatment includes radiation and geometric corrections.

c)Surface salinity remote sensing quantitative model building: use of various types of data obtained by analyzing the spectral characteristics of water bodies, water salinity yellow substance and relevance, yellow substance-reflectance, water quality parameters to determine the best estimate of the band or bands portfolio, build relationships based on quantitative parameters of remote sensing data and salinity between the yellow substance, so water salinity information retrieval.

d) Surface salinity estuary Quantitative Remote Sensing Inversion: The salinity of quantitative remote sensing inversion model constructed the inversion of the Pearl River estuary salinity information through remote sensing data to obtain a long series of Pearl River Estuary surface salinity change information.

e) Results of output: two forms, one is the result of consolidation of storage, namely

the establishment of salinity remote sensing information repository through GIS platform; another achievement is finishing a map, remote sensing software, image processing software will salinity information a state diagram showing the distribution of salinity.

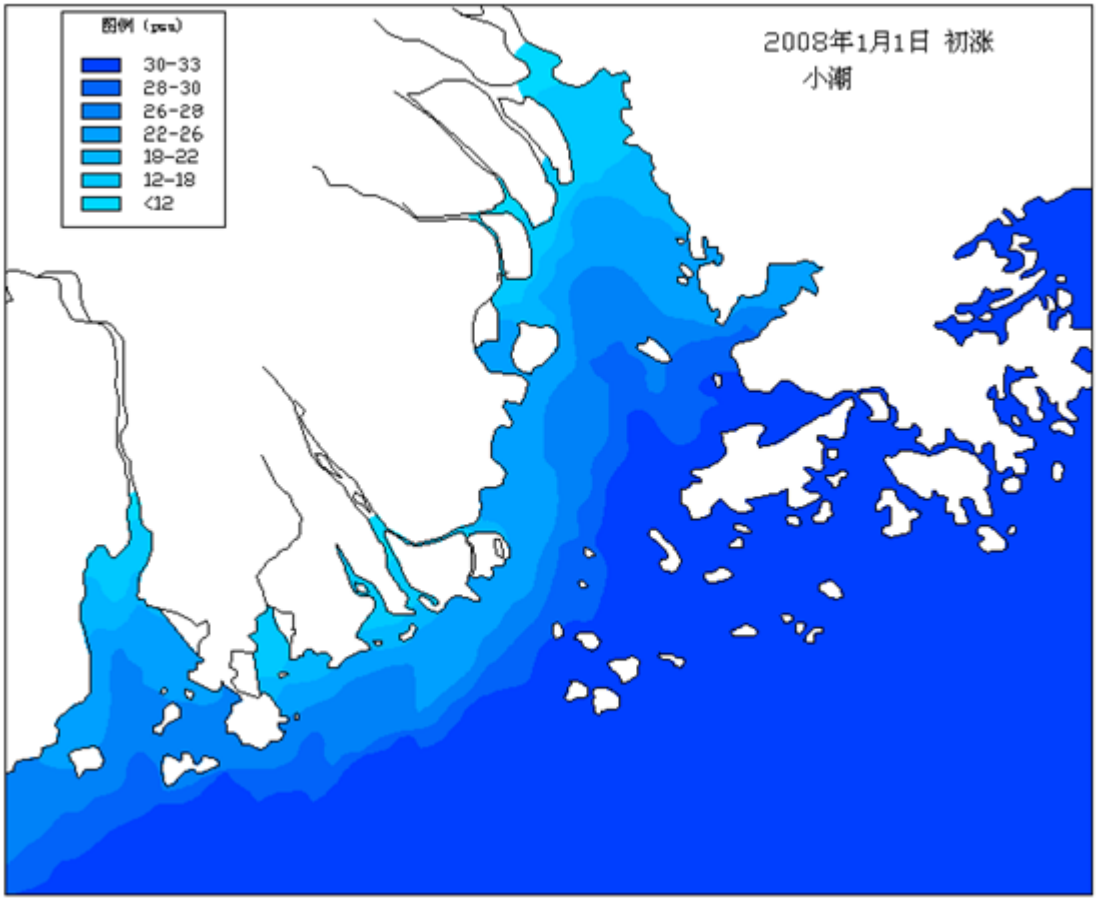

Figure 2.1.1 E.Beginning surface salinity distribution of Pearl River Estuary in high-water of low tide

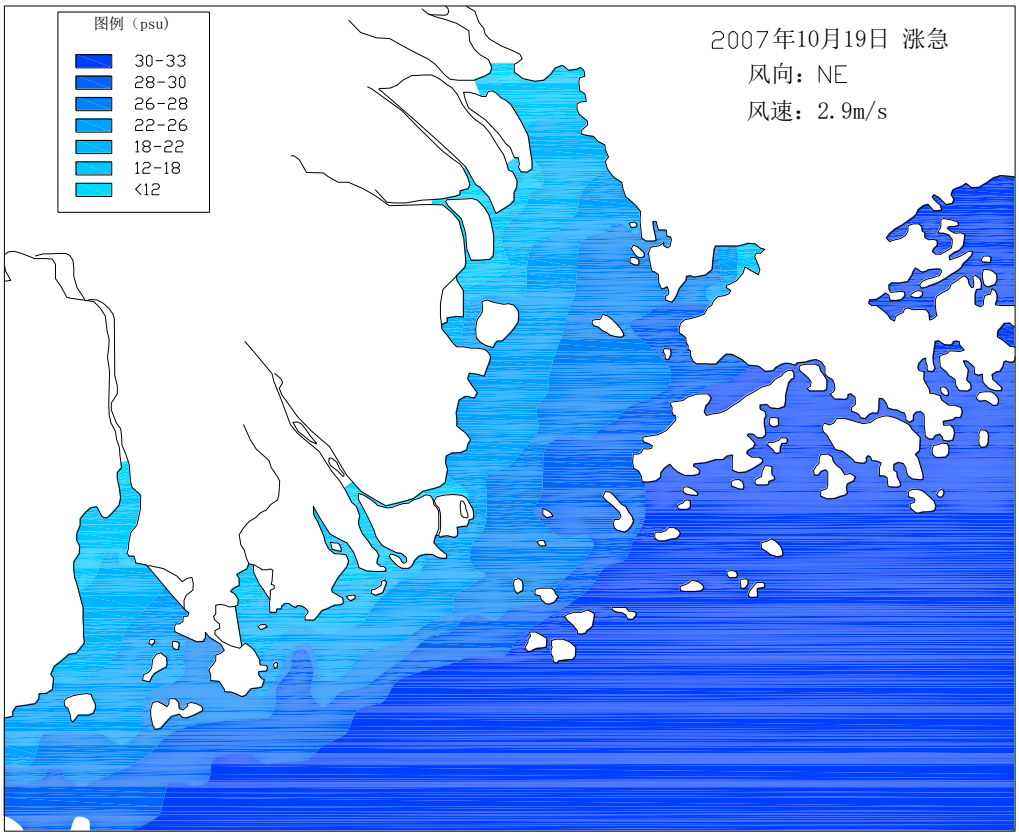

Figure 2.1.1 F.Middle surface salinity distribution of Pearl River Estuary in high-water of low tide

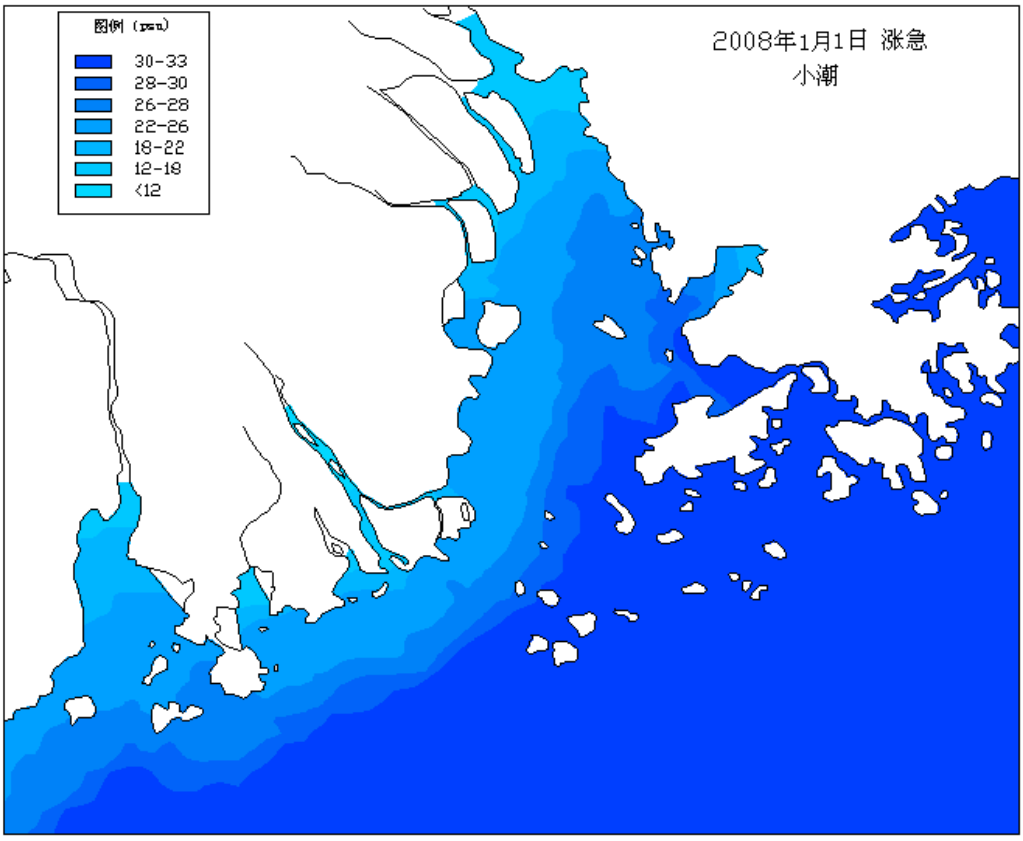

Figure 2.1.1 G. Peak surface salinity distribution of Pearl River Estuary in high-water of low tide

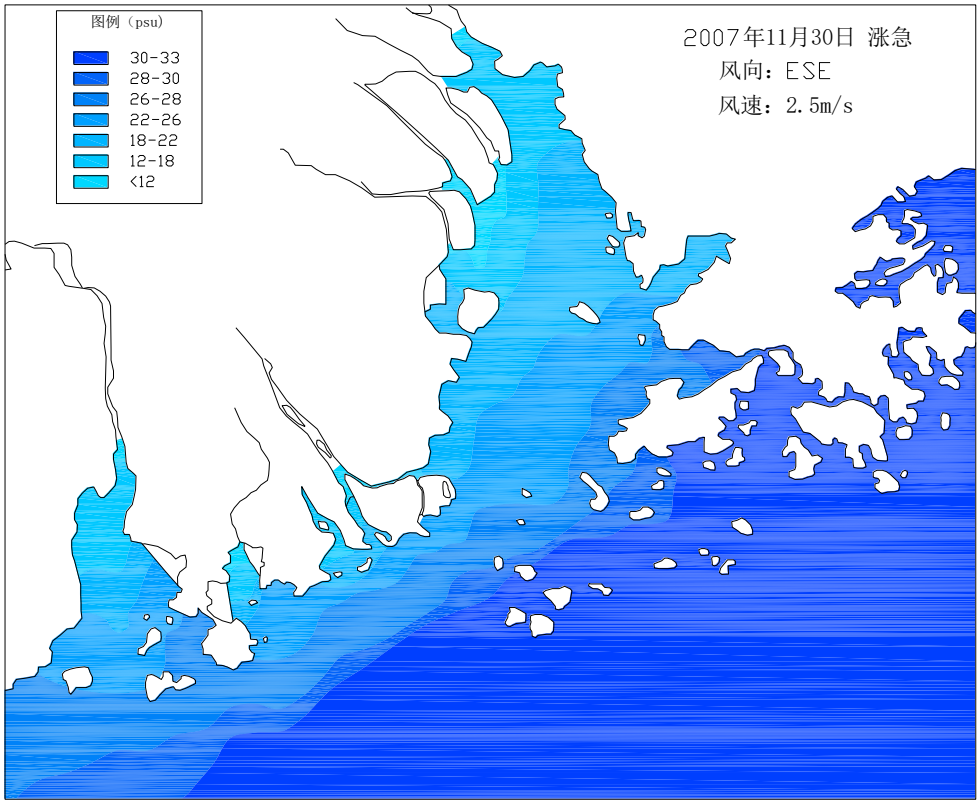

Figure 2.1.1 H Surface salinity distribution of the rising tide in acute phase of Pearl River estuary

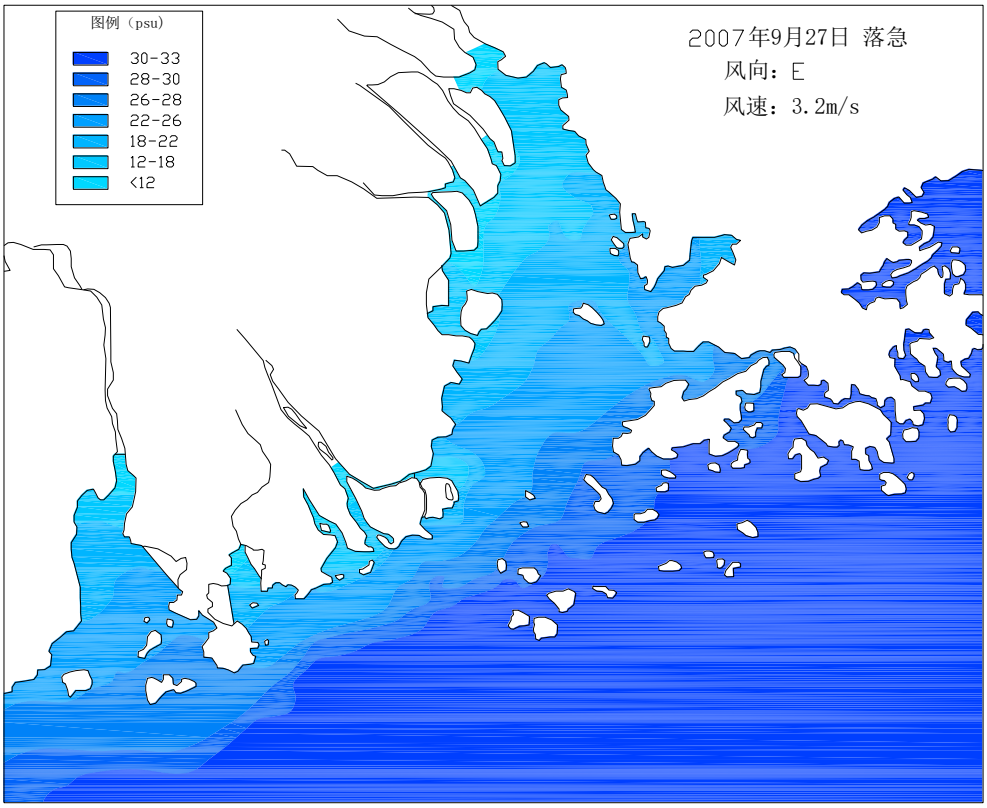

Figure 2.1.1 I Surface salinity distribution of tide-off at the beginning stage of Pearl River estuary

(3)Study on salt tides movement rules and pluralistic power coupling mechanism

Multi-method, the method of combining new technology for the next multi-dynamic coupling of wind, wave, current, tide and so fresh and salt water mix, transport mechanisms and Salt Movement mechanism research breakthrough, and promote the estuarine dynamics density points Advances in laminar flow.

In the salt tide multifactorial response activities on the basis of the study, constructed salinity transport and diffusion theory model, derived concept sink constant stream length saltwater wedge formula proposed minimum "tidal range thresholds" saltwater intrusion distance; Unlike other country found the Pearl estuary salt tide traced the phenomenon reveals Modao Station salt tide goes back half tidal cycle peak in tides, salinity upstream section first appeared in the downstream section of the peak of phenomena such as dynamic mechanism; for the first time using a physical model of the slow mixing the salt tide estuary pilot study analyzed the characteristics and changes in river salinity changes of salty runoff circles under proposed correspondence between Saltwater intrusion suppression salty flow and strength.

On the mechanism of salt tide movement traced by the measured data and

numerical simulation results analysis, and salt tide Modao Station traced patterns and dynamic mechanism Hongwan tributary waterways were discussed. The results show that the salt tide Hongwan waterway traced the half-cycle variation of day and have a good relationship with the tide; day cycle variation Modao Station traced the same salt tide has good correspondence between the tides, but its half-cycle variation of the exhibit is a special phenomenon: the salt tide traced the strongest and weakest moments appeared in neap tide and the tide after the period. Modao Station salt tide goes back a half-cycle variation of the dynamic mechanism is more complex, dynamic process under the combined effect of runoff, tides and terrain effects of different salt and freshwater mixed state alternate transformation, different salt mixed state produce different substances Delivery form: low tides, the underlying surface is significantly greater than the accumulated salt flux, net transport direction is landward; tides, salt flux surface is significantly greater than the underlying cumulative net transport direction towards the sea; and the balance in general appear to the tides, which is traced back Modao Station salt tide strongest and weakest moments and appeared at neap tide after the tide of reason.

This research finding to develop and implement the Pearl River Delta is becoming salty suppression countermeasure scientific basis.

(4) Real time monitoring and forecasting system

Different ways to control the salt tide traced, we must first be traced back to the salt tide situation might be predicted, to select the most economical and reasonable response options. Therefore, the premise of the rational use of the salt tide control technology is the salt tide warning and forecast accuracy, and predictive accuracy of forecasting accuracy depends on the density and the salt tide observation data. Systematic, comprehensive, accurate and timely information and analysis on-site monitoring results and the detailed structure helps to understand and resolve the estuary power can provide the most direct source material for scientific experiments and projects. In recent years, the salt tide in the Pearl River Delta for real-time monitoring and early warning and forecasting work was carried out mainly in the following aspects:

① Completion of the salt tide information gathering mobile platform

Estuary salt tide observations can be fixed station monitoring, mobile monitoring, multi-platform Remote Sensing combination to form three-dimensional multi-angle monitoring network. Among them, the fixed monitoring stations in each water district has laid the Pearl River estuary, but the Pearl River Delta region have been built or Salty water quality monitoring sites, by different departments or agencies to invest in its position is for a specific region or a specific the purpose of the service, the lack of overall planning and design, it is difficult to meet the needs of the entire Region salt tide monitoring and research work. Salt tide information collection platform mobile global positioning technology (GPS), wireless transmission of data (GPRS), digital camera technology (DC), microcontrollers and embedded operating

system technology, and the background geographic information system (GIS) technology, the use of wireless communications and computer Internet, various distributed information is written directly to this platform, such as the salt tide data, live pictures and information to achieve the wireless transmission of information to move the salt tide monitoring and data.

② Building up and improving the estuarine salinity retrieval and dynamic monitoring of remote sensing technology

Whether it is a fixed station or mobile station, which is the value of the salt tide data acquisition sampling point, could not get the salt tide plane distribution information, salinity quantitative remote sensing methods can be characterized by the salt tide acquisition plane distribution.

Water sample data, spectral data and satellite imagery based on the simultaneous measurement by salinity, yellow substance, spectral analysis of the variables and other information derived Pearl River estuary salinity and yellow material relationship established salt applied to the surface of the Pearl River Estuary quantitative inversion model to solve the technical problems estuarine salinity remote sensing monitoring. In addition, the model through operational improvements, the formation of a salt tide estuary Remote Sensing Dynamic Monitoring of standardized business processes, to achieve the Pearl River estuary salinity remote sensing routine monitoring.

③ Setting up a platform for the salt tide warning and forecast

After more than ten years of research and practice accumulation constructed platform salt tide forecast report, including the salt tide multi-source data management and analysis platform, offshore tide forecasts components in the upstream hydrological forecasting components dimensional estuary salt tide forecasting systems, estuaries D High-resolution numerical simulation platform. On this basis, in the Pearl River Hydraulic Research Institute of Pearl River Water Resources Commission to establish a dynamic monitoring and forecasting salt tide demonstration bases for Modao Station conducted demonstration applications, to achieve rapid salt tide forecast, according to statistics, 1, on the 3rd, the 5th and the 15th in the forecast average prediction error aging were 10.04%, 16.43%, 20.71% and 36.56%, for the development and implementation of the Pearl River Delta salty suppression measures provide a strong technical support

2.1.1.2 Non-engineering Measures/Policy and Regulation Measures

(1)Comprehensive Plan for the Pearl River Estuary

In order to strengthen the comprehensive development of the Pearl River Estuary and the protection and maintenance of the Pearl River Estuary tidal vent Hongna function, co-ordination and regional flood control basin, moisture, water, shoreline

and beach protection and utilization, shipping, sand, water and other ecological and environmental protection relations, to support sustainable economic and social development of the Pearl River estuary, according to "People's Republic of China Flood", Ministry of Water Resources organize the preparation of the "Pearl River Estuary comprehensive Management plan" (hereinafter referred to as the "Plan"). In 2010, the "plan" has been approved by the State Council. "Planning" on the main waterway sand control planning were proposed mining area and no-take zones. According to protect the flood safety, maintaining channel stability, conducive to the orderly development of the principles of the estuary, divided recoverable river channel and the ban on logging, planning Prohibited river 1147.1km, recoverable river 293km.

"Plan" that "affect the salt tide traced exacerbate serious security threat to the water supply" is the new situation facing the estuary governance; at the same time, "plan" put forward to carry out "special studies governance salty harm," the work requirements, intended to strengthen hydrological forecasting and Salty capacity-building, the salt tide forecast system, killing strengthen basic research activities related to the salt tide in order to master a variety of factors upstream runoff, estuaries topography, tidal estuary salinity offshore area, wind farm, offshore area along the stream, such as joint action Pearl River estuary salt tide activity under the law.

(2)Safeguard Macau, Zhuhai Water Supply Security Plan Special Plan

To fundamentally solve the salt tide goes back to the Delta region of Macau, Zhuhai and other water problems brought to protect the long-term prosperity and stability of the region, the Pearl River Water Resources Committee in February 2006 began to organize the preparation of "safeguard Macau, Zhuhai special water safety plan plan "(hereinafter referred to as" Plan ")," planning "in 2008 by the State Council for approval.

"Planning" from the height of basin water resources configuration, a comprehensive look at water problems exist in Macau and the Pearl River Delta, the study basin level to protect water security, water ecological security measures Macau, Zhuhai and so on Delta, is a comprehensive solution to Macau, Zhuhai Water Supply fundamental program security issues.

"Planning" analysis pointed out, Macau, Zhuhai major factors affecting the water supply has two aspects: First, the local water supply projects defective; the second is the upper reaches Pianku resulting salt tide intensified. The former needs to resolve to improve local engineering layout, which is a variable number of factors runoff, terrain, and other affected by tides.

"Plan" that a comprehensive solution to Macau, Zhuhai Water Supply problems need to take reasonable water resources allocation, improve local water supply project layout and comprehensive measures to strengthen the unified management of water

resources. But in the past 10 years, the impact of Macau, Zhuhai Water Supply Modao Station salt tide will not be effectively curbed.

Therefore, in order to safeguard Macao, Zhuhai and Delta water safety short and long term, "plan" drawn up short and long term objectives, implemented in phases. To 2010, a comprehensive water conservation, pollution prevention of pollution, improve local water systems and other infrastructure, through integrated water resources scheduling, basically solved Macau, Zhuhai Water Supply security issues; forward to 2020, through the improvement to Datengxia etc. Reservoir Basin water theme measures and water resources engineering system scheduling management mechanism, a comprehensive solution to Macau, Zhuhai water Supply security issues.

The Pearl River Water Resources Commission has three steps to promote the "Plan" implemented. The first step is to improve the security system of water basin, good integrated water resources management and water transfer dispatch scheduling, while strengthening the social construction of water-saving and pollution prevention, along the provinces and territories to increase water conservation efforts to improve the dry season the river base flow . The second step to improve local water supply systems, construction of reservoirs, pumping stations and improve the ability to build a light tone salty; at the same time, according to the law to strengthen the Pearl River estuary water administration, standardize all kinds of water activities, curb cut down the river, salt tide traced enhanced momentum . The third step is to actively promote Datengxia Hydro building regulatory capacity to improve water basin.

(3)Pearl River Water Regulating

For many years the amount of water in the Pearl River Basin unified, effective response to the adverse effects caused by the salt tide goes back to ease the tensions of water Pearl River Delta region, and achieved good economic, social, political and ecological benefits, and accumulated a wealth of water dispatch management experience. But water dispatching management process exposes contradictions unclear responsibilities urgently requires legislation to strengthen integrated water resources management. From 2007 onwards, according to the Ministry of Water Resources to deploy, Pearl River Water Resources Commission conducted legislative research, demonstration and organization "of the Pearl River Water Regulating" (hereinafter referred to as the "Regulations") in drafting research. After much research to modify, improve, in April 2009, completed the final draft "of the Pearl River Water Regulating (draft)" and "legislative necessity and importance, feasibility reports," the five technical thematic reports. Currently, the relevant provisions of the revised and improved verification and methodical work are carried out.

Promulgated the "Regulations" is to strengthen the unity of the Pearl River Water Resources scheduling, protection of urban and rural water supply and ecological security, optimize the allocation of water resources and sustainable use, and promote economic and social development of the Pearl River Basin. The

"Regulations" to define the purpose of the legislation establishing the guidelines, principles and scope of water regulation, water regulation establishing the organization and management system, clear responsibilities of various departments, the establishment of a water regulation plan for water resources management mechanism in line with the characteristics of the Pearl River, and a scientific and reasonable scheduling system implementation procedures and penalties. It is reported that the "Regulations" also solicit Yunnan, Guizhou, Guangxi, Guangdong provincial people's government departments and China Southern Power Grid and the Pearl River water dispatching management related work, Guangxi Power Grid and other units' comments to revise and improve.

2.1.2 Current Major Problems of Salt Tides

In recent years, significant changes occurred basin hydrological regime, the Pearl River estuary salt tide is moving in a negative direction, it goes back strength, scope, frequency and duration have a growing trend, mainly as follows:

- Under natural conditions, the total amount of less than normal runoff upstream in dry season, a key node runoff distribution ratio decreased downstream river runoff due to reduced salt tide of early arrival and the whole community salty shift;

- Under the Pearl River area bed nets cut, estuary dredging frequently, research shows that cutting down the riverbed, river channel volume increases will enhance the salt tide goes back power, is considered to be one of the major factors that aggravate the Pearl River estuary salt tide traced ;

The same flow conditions, the salt tide traced prolonged, increasing the degree. In 2009, Zhuhai pinggang Chlorinity begin pumping stations exceeded on September 15, nearly two months earlier, salty sector than in previous years on the move for about 10 km. Salt tide influence August 27, Guangchang pumping station of the Zhuhai-Macao chlorine water systems appear exceeded 24 hours, compared with recent years; in 2011, the first salt tide occurred July 28, is the first time since records began the most serious one month earlier in 2009; December 22 days of continuous chlorine level exceeded 24 hours, compared with the previous years under the same conditions runoff, take short odds reduced from 25% to 0%. With the continued and growing occurrence of salt tide, over the past decade, the salt tide in the Pearl River Estuary domestic scholars on the issue carried out a lot of research, but the river and Salt complexity of the problem itself, many problems remain unresolved, quantitative response relationship, and thus unable to salty main factors such as changes in the sandbar, wind traced the mechanism of action of the salt tide, salt tide goes back to the upstream node split ratio of key changes under the riverbed cut, rising sea levels and other factors of contribution rates, trends, etc. to make a scientific judgment, it is difficult for the dry season water basin unified provide accurate decision making. Plus the combined effects of increased water consumption in the region and other factors, salt tide traced remains a major threat to Guangdong, Hong Kong and Macao supply security.

2.1.2.1 Inadequacy of Existing Measures

Currently, the main problem is dealing with the salt tide threat as well as protecting the Pearl River Delta and Macao Water safety face, they include:

(1) Under the same flow conditions due to prolonged traced salt tide, it increases the degree of suppression of salty scheduling more difficult, required suppression salty flow increases year by year, less salty suppression effect of controllability and predictability;

(2)Water allocation capability and means have inadequate suppression countermeasure salty way more single backbone in the upstream reservoir storage shortage year, salty suppressing existing control measures will become stretched;

(3) Further optimized layout of the water intake room is small, Zhuhai, for example, has bamboo Chau Tau Pumping already in the river upstream boundary of its territory, and its movement will bring high costs and a series of questions;

(4) The results of the current study focus on the salt tide Modaomen, salt tide problem is more short of research North River, Dongjiang River Delta.

2.1.3.2Regulation management mechanisms and related laws and regulations are incomplete

(A) The Pearl River water management process has many contradictions.

(1) It covers a wide range of water dispatching management, coordination difficult. Consecutive years of water regulation is mainly relying on administrative means to implement, but because of all kinds of reservoirs in the upper reaches of the Pearl River Hydropower belong to different regions and industries, involving many departments, coordination difficulties, driven by profit, in violation of the scheduling discipline, does not execute the transfer order situation have occurred; the other is difficult to manage the functions of the basin between wading cross-sectoral, deletion, there is no standardization and legalization of coordination mechanisms, alone administrative means to coordinate all aspects very difficult. For example, in water regulation process, there have been at a high administrative level grid companies refused to send senior leaders to negotiate, even sent dispatcher participation in general need to schedule a consultation meeting of high-level decision-making; September 2006 in Longtan reservoir built to defy dispatch instructions, do not follow the Pearl River flood Control and drought Relief Headquarters impoundment schedule requirements, to increase the difficulty of scheduling work; early February 2007, Cheung Chau Hydro refused to implement the State Flood Control and drought Relief Headquarters and the Pearl River flood Control and drought Relief Headquarters instructions, unauthorized organization cofferdam, resulting Wuzhou traffic fell 6 February 1800 m3 / s or less, seriously affecting the dispatch plan.

(2) It has temporary emergency measures starting cumbersome, costly, low administrative efficiency. Pearl River water is from the continuous scheduling practices and the effect of five years, despite reaching scheduling purposes, but there are many problems: first, the high cost of temporary scheduling measures. On the one hand, temporary emergency measures will increase the difficulty of scheduling and production efficiency power plants, and on the other hand, because there is no set plan of measures, start-up time and conditions cannot be guaranteed to each other, when the temporary emergency measures to start, there are upstream reservoir anhydrous adjustable or controlled much of the water situation; the second is to start cumbersome, low administrative efficiency. Take administrative measures such as scheduling each startup by the Prime Minister or Deputy Prime Minister instructions, there are many other factors complicated the implementation of the conditions and approval procedures. Therefore, in order to fundamentally solve the contradiction between water transfer and power transfer, to achieve win-win situation, it should be done according to the law from the management system, strengthen regulatory agencies and watershed dominant power dispatch center of the FBI in hydropower position to achieve "early prediction and early deployment of the" save the program start time, thereby reducing dispatch costs and improve administrative efficiency.

(3) Water regulation is involving the main interests of hydropower reservoirs that need to be regulated from the perspective of building harmonious society legislation. Measures on the one hand, include "the Pearl River Basin Water Resources Planning" the backbone of the middle reaches of the Pearl River hydropower reservoirs that are mostly not given water allocation functions, scheduling work involves stakeholder interests between the government and enterprises, citizens, etc., to take their interests involved Therefore the need for legislation to regulate; on the other hand, the relevant law does not expressly give the State Flood Control and drought Relief Headquarters, Ministry of Water Resources scheduling functions under normal and emergency dispatch is only a temporary administrative measures, the excessive use of, cause simply the pursuit of the public interest, public order and public management efficiency, cut and protect their private interests, to achieve the intrinsic link between social justice, and cut the intrinsic link between procedural justice and substantive justice, thus affecting the executive credibility.

(B) IWRM legal system basin imperfect and scheduling means are weak

(1) The current water regulations are to implement the provisions of basin water resources allocation and unified management is not clear. They can only rely on an executive order scheduling. The current water regulations are to watershed as a unit of water resource management and scheduling make provision, but some of these provisions are to establish the basic system and principles. For example, river basin management and regional management combine their respective duties and powers issue, the status and effectiveness of the annual water allocation plans and scheduling plans, water regulation authority and responsibility is not clear, and so

the relevant law does not make it clear that, therefore, need administrative regulations by specific provisions related to the above systems and specific enforcement measures.

(2) The introduction of new "drought ordinance" fails to address the implementation of basin water basin agency unified configuration and to unify scheduling problems. The latest version was issued in February 2009, the "drought ordinance "that established a series of important drought system, including standardized water regulation coping with droughts, protect life, production, ecological water, so basically the same as the legislative purpose and "Pearl River Water Regulation Bill." Diversion is an important measure of drought, but the "drought ordinance" is not a substitute for "Pearl River Water Regulating": first, due to water shortages, the "drought ordinance" object adjustment is caused by drought, and in recent years the implementation of the Pearl the reason is not caused by drought because of water regulation, but in the dry season affected by the salt tide goes back, in addition to the upstream reservoir caused by non-uniform power plant scheduling, so as "drought ordinance" does not cover issues like the Yellow River, "drought ordinance" the same issue cannot be covered by salty Pearl River; second, "drought ordinance" for drought relief work is mainly responsible for the implementation of the regional executive heads of the system, flood control and drought relief headquarters agency responsibilities basin drought work is only responsible for "coordination" for inter-provincial the River water regulation, there is no clear specification to be no real powers conferred basin water regulation agency. Therefore, under the "drought regulations", the basin agencies cannot achieve integrated water resources configuration and unified.

(3) As the Pearl River water regulation is unclear, it affects the normal development of scheduled work. "Water Act" establishes management and administration of water resources management system, combining regional watershed management, but the relationship between river basin management and regional management of the flow is unclear due to historical reasons, the basin organization is difficult to perform well maintenance of river health, a good spokesman for rivers responsibility post. In addition, the current legal status and duties of river basin organizations unified implementation of water is still not clear, for hydropower reservoir flood limit water level below the normal water regulation authority, the relevant law does not explicitly State Flood Control and Drought Relief Headquarters, the right to decide. Therefore, by legal means, to compensate for river basin water resources allocation capability and means of technical and management problems that exist in inadequate mobilization belong Reservoir Group has built FBI effects of different regions and industries, comprehensive benefits maximum use of existing works, so that watershed optimal allocation of water onto a legal track.

(4) Scheduling management protection mechanism is not perfect, the implementation measures are not effective, the impact of the effect of scheduling. At present, for the management of water resources in the scheduling code of conduct,

supervise and inspect the implementation of administrative intervention and lack of appropriate measures to protect the system. Water Law, Flood Water Regulation for accountability provisions are not clear, and the corresponding liability for breach of scheduling instructions chase and rescue system of supervision and inspection powers, duties nor specific provisions, affecting the scheduling effect. For example, in the Pearl River Water Regulation implementation process in the construction of Cheung Chau Hydro illegal closure of the critical period in the schedule, a sharp decline in the water level downstream river water, scheduling programs and diversion to the test outcome. Despite urgent remedial measures to reverse the passive situation before, but according to the current water regulations, no administrative sanctions for such violations, only in accordance with the Administrative Supervision Law, by the superior units to internal administrative sanctions, which is currently the water administrative regulations existence of weakness. So pass legislation setting strict administrative coercive and punitive measures, so that the law, providing legal protection for the Pearl River Water Resources unified.

2.2 Regarding Natural Disasters

2.2.1 Current Challenges of Disasters Control

Pearl River Basin Delta is located in a typical monsoon zone, annual rainfall is abundant, but the spatial and temporal distribution is uneven, causing floods are frequent, especially in the Delta River and the most serious. At the same time, it is one of the regions that are most frequently affected by tropical cyclones and typhoons often subject to direct attack, and often accompanied by the occurrence of strong winds, heavy rain, storm surge, flood, floods and other extreme hydro-meteorological events, can easily cause serious natural disasters, and lead to serious life and property losses. Therefore, flood tide disaster has always been a big worry for the Pearl River Delta.

2.2.1.1 Floods

Pearl River Basin frequent heavy rainfall, the frequency of occurrence of floods in the basin is the best, the most damaging natural disasters, especially in the Delta River and staggering. July 1915, West River and North River simultaneous 200-year flood, the two rivers downstream embankment and almost all outbursts Delta, Guangzhou inundated seven days, the victims of the Pearl River Delta 378 million, 648 million mu of arable land affected, killing more than 10 million. 1915 - 1949 35 years, more than 100 million acres of arable land affected by flooding in the basin of 22 times, including 1947 flood and flood affected population in 1949 were more than 400 million people are affected more than 600 million acres of arable land; after the founding of New China in 1959's East River flood, 1968 and 1994 of the West, the North River water, 1982 North River water, flood Liujiang 1996, 1998 West River flood, etc., the affected population are more than 1 million people, affected more than 100 million acres of farmland, of which, in June 1994 flood, Guangdong,

Guangxi and the affected population of nearly 18 million, the direct economic losses amounted to more than 280 billion yuan.

2.2.1.2 Tropical cyclones and storm surge

Southern coast is one of the most affected by tropical cyclones frequently invade the region, the Pearl River estuary storm surge caused mainly by tropical cyclones. Tropical cyclone disaster mainly for immediate disaster caused by strong wind, floods and typhoons and storms formed storm surge due to strong winds, caused by low pressure.

Since the founding of the Pearl River estuary area almost every year will be subject to tropical cyclones and typhoons (above 8 tropical cyclone wind) attacks, maximum gusts up to 50 ~ 60m/s or more strong typhoons are not uncommon, 70% to 80% of typhoon will bring heavy rains and torrential rain landing. Strong typhoon disasters always led to huge disasters within a few hours. According to statistics, the typhoon landed in Guangdong province an average of 3.6 per year, Guangdong Province, the average annual typhoon caused direct economic losses of 4.689 billion yuan. 1862 history of the Pearl River estuary, a direct result of the storm surge more than 80,000 people were killed; "8309" typhoon storm surge, resulting in the Pearl River Delta affected population of 120 million people, the death of 45 people, affected 344 million mu of farmland; number "9316" Typhoon , resulting in 11 City of Guangdong Province 37 counties (cities) affected, the affected population of 569 million people, the death of 25 people, affected 306 million mu of farmland; severe floods in 2006, typhoon "Bilis" and "pearl" to bring in Guangdong , the affected population over 7.4 million, 366 people died, 40.5 billion yuan in direct economic losses; 2008 strong typhoon "Haig than" after landing in western Guangdong, Guangdong's total direct economic losses of nearly 11.825 billion yuan.

2.2.1.3 Urban floods

In the context of global warming, extreme weather disasters around the world have increased significantly under the current conditions in China's rapid economic development and urbanization, urban waterlogging becoming one of China's major natural disasters. Pearl River Delta region are subtropical monsoon climate, the future of this extremely strong regional precipitation still continue to occur and may even be more frequent. Guangzhou, for example, since the reform and opening up, has expanded urban area with short-term exhibits dense urban waterlogging-prone situation. Especially in the new century, almost every year in Guangzhou urban waterlogging occurs, but the severity was different. May 2010, Guangzhou continuous heavy rainfall occurs five times in a month, resulting in a large urban area floods. May 7 morning, Guangzhou districts heavy rain, urban traffic immediately paralyzed downtown area ten serious waterlogging, some roads depth of as much as 3m, 200 multi-vehicle rapid bus broke down, Baiyun Airport 138 flights were delayed, 35 underground car park experience "disaster", was soaked up to 18,000 vehicles. May 14, Conghua, Huadu, Baiyun District and the city have been a strong

thunderstorm, 99 waterlogging occurs, more than 50 roads to flooding or water deeper phenomenon, 2l main road paralysis, comic City highway is also a risk of flooding, some of the vehicles are also blocking the road after 6h. BRT line many flooded, Metro Line 2 to suspend the service due to water seepage, the Guangzhou Railway Station to become water, Tianhe Bus stranded six or seven passengers, 57 flight delay Baiyun Airport, thousands of passengers stranded. On May 11, 2014, it rained from 6:00 am to 16:00 pm with the city's average rainfall of 177.7mm, the maximum rainfall 363.8mm was in Longhu; maximum rainfall in one hour was 89.3mm. At 13:00 same day, Shenzhen city's meteorological department issued the red rainstorm warning, Shenzhen City headquarters of the anti-flood emergency response grad IV promoted to grade III, heavy rains in the city state of emergency defense. Under heavy rain, Shenzhen city was a flood plain. About 150 road water, Baoan 107 State Road, Longhua District Furong Road, where North train station tunnel, Nanshan Taoyuan and other places were overwhelmed by water over 1m. Area waterlogging occurred about 20, including a village Nanshan district, Sakata post new East Village Lane, Tian Industrial Road, Longhua District Building, severe waterlogging and other oil-fu Village, Shenzhen University and other various places can "see the sea." Urban traffic has been affected. As of 21:00, heavy rain led to the Shenzhen Airport has canceled more than 130 flights sorties, delayed more than four hours of outbound flights more than 70 classes, a large area of flight delays red alert. Since 14:00, the Guangzhou-Shenzhen line motor car parked across the board to open a total of 40 pairs of train outage. Due to heavy rains, the city's total of more than 400 lines of nearly 5458 buses, station by water, the water cannot be normal operation of the road, where the new energy vehicles 2693 outage; 2765 conventionally powered buses according to the road, the station actual water, etc., cannot be part-time sections of normal operations. About 2000 cars were flooded, and some trapped vehicles have been timely transfer of personnel.

2.2.2 Current Major Problems of Disasters Control

(A) Main Flood situation changes, opening the door exacerbate to the flood task

Pearl River Basin Flood situation occurs mainly two major changes, one result of the West River dike heightening thick on both sides, leading to significant flooding go through phenomenon occurred in recent years, "9406", "9407", "9806", "0506" Great Flood reflects, in the case of upstream flood of similar magnitude, Wuzhou station increasing flood magnitude, inject Delta also will increase flood magnitude, such as the Delta station horse mouth section "0506" flood peak flow reached 53200m3 / s, approaching 1915 flood; the second is the riverbed Delta waterways changed dramatically under the North River riverbed cut severely, North River waterway and the East China Sea waterway riverbed average cut of more than 2m, Shunde waterway deepest under cheddar 5m, net river area rivers cut inhomogeneity leads to two important changes in the shunt node flood diversion ratio, the West, the North River flood increased four-door east bleeder proportion, when 50-year flood flooding Sanshui station distribution ratio increased by 2% ,

thereby increasing the flood task North River flood control pressure part of the river mouth and stuff doors.

(B) Increase the degree of influence of typhoon storm surge, moisture situation is grim

Pearl River estuary facing the South China Sea is the storm surge disaster-prone areas, moisture grim. Over the past decade, the Pearl River estuary to increase the degree of influence of typhoon storm surge, storm surge water level entrance several times over the history of the highest level, such as typhoon "9316" sign, cross the door hydrological stations tide level reached 2.62m, Modao Station lantern landscape Man tide station position reached 2.65m, the culmination of more than a history of the measured position; 2001 "Ute" typhoon, storm surge water plant in Guangzhou buoy up 2.62m, over historical climax bit 0.18m.

In addition, typhoons often accompanied by heavy rain, in the case of storm surges, floods, and at the same time suffered astronomical tide, prone to dilute the case of probabilistic flood tide level, causing serious disaster losses.

(C) Increased waterlogging caused by urbanization, it is difficult to improve in the short term

In the context of global climate change, spatial and temporal distribution of precipitation in the Pearl River Delta inhomogeneity gradually increased, storm rainfall intensity increased and more focused, easy to form waterlogging. Meanwhile, with the acceleration of urbanization, land use patterns undergone structural changes, the original suburbs into the city, the rapid increase in impervious area, storage, stagnation, the ability to quickly seepage loss, increases the underground drainage channels drainage pressure; urban development of long-term heavy ground light underground drainage network facilities, the lack of long-term planning, design standards low, currently the major cities of skyscrapers, underground drainage network transformation very difficult. Although Shenzhen is the youngest city in China, but in the 1980s, initially built in the city of Shenzhen is also the use of the concept of urban development of the Soviet Union, the Soviet Union due to less rainfall, drainage channels lower standard, which led to the construction of the Shenzhen drains did not fully consider the future urban development. Thus, although in 30 years, Shenzhen have built more than 13,700 km of sewers, but encountered heavy rain, these pipes cannot be due to rainwater discharge, often resulting in multiple areas of the city flooded. According to reports, most of the drains in Shenzhen is a case of the 1-year to construction. In case of a one-year standard hourly rainfall intensity is approximately equivalent to 50mm, of course, unable to cope with the huge rainfall. In some areas, it could not drain away rain water and thus they were ruinedinto “ocean”.

(D) Lack of mainstream West River flood control project controlling flood regulation

West River catchment area 35.31km2, accounting for 88.3% of West and North River basin area. Pearl River flood threat mainly from West River, but no natural lakes West River flood storage, flood control reservoirs controlled "utilization of the Pearl River Basin Planning Report" determined, in addition to White River Hydro Longtan Hydropower Station, a tributary upstream Yujiang in addition, no other construction, flood control along the river embankment to rely on a single project, the lack of effective means to control the flood, flood pressure downstream and the Delta region is enormous.

(E) Dike length, more hidden, low standard, high risk

The total length of over 12,000 Pearl River dike km, a general increase is not enough, thin dike, the existence of different levels of water seepage, take sand and Chuandi aging buildings in disrepair and other hazards (including the North River levee embankments and other key), flood control embankment of long-term ability of many in the 10 to 20 year return level, there is a considerable part of the flood defense embankments only once in 10 years or less. In recent years, with the pace of the construction of the upstream regions to speed up the embankment, flooding go through the phenomenon has become more evident, increasing the pressure on the downstream flood control areas, coupled with the long bank lines, the defense is difficult, increasing flood risk, flood protection in the form of very grim.

(F) River up barriers, poor estuary flood

When flood land encroachment, disorderly reclamation, illegal construction of buildings and indiscriminate wading river sand, dumping of waste in the river debris, sand and gravel have occurred, affecting the normal functioning of river and flood spillway features smooth spilled into the sea, increased flood control pressure in some areas. In addition, human activities in Pearl River estuary area and the gate area of the impact on flood control is also more prominent.

2.3 Regarding Water Pollution

2.3.1 Current Challenges of Water Security

According to the Guangdong Provincial Water Resources Bulletin from 2001 to 2010, the Pear River Delta's waterways (Zhaoqing above), North River waterway (Lubao above), Tanzhou waterways, Ronggui waterway, the East China Sea waterway, Chen CunXiaolan Watercourse, chicken crow waterway, North waterways, Modao Station upstream river flow field above the Pacific, by Jiang Licheng above and other river water quality, as II-III class. Southwest Bay, Bainihe, Guangzhou West fairway, fairway before Guangzhou, Guangzhou after the waterway, watercourse Panyu, Shunde waterway, Huangpu waterway, Ping waterways, Shiqiao waterways, Fen River, Foshan waterway, watercourse upstream coke door, Yamen Channel upstream, Dongguan waterways and East River Delta river network pollution, excessive water quality for many years, with the V and worse than the main. Eight Pearl River entrance, except for Class III Humen, the rest are lower than Grade III, the main factor for fecal

coliform contamination.

West River in 2006 had previously been held in Grade II water, the first half of 2007-2010, changes in water quality, the horse mouth, clever section many times worse than Grade V class and between classes to inferior class II-V.

North River water system before the end of 2008 has been maintained at Class II water, Lubao section of water remained in Grade II water since early 2009, Sanshui section of water between Class II-V inferior class to change; Shunde waterway as the water quality is relatively concentrated water before 2005 water quality is maintained in Grade II-III, after the changes in 2005, the amount of water Shunde waterway sheep and South Island water intake segment as of March 2010 reached the inferior quality between Grade III-V to inferior class.

Pearl River water quality before and after the channel for the past 10 years has been inferior Grade V, there were only individual sessions Grade IV water; West River Guangzhou and Dongguan since after entering the water quality deterioration, water between III-IV, the water quality in 2003 before later in 2003 more in between III-V, and most of the time around the location of the inferior class V. Flow River water quality is better than Taiping, Taiping following poor water quality, more or less in class IV water, after entering into inferior class V Guangzhou city; V class has Bainihe inferior water quality over the past decade.

Tanjiang Source Water Quality Class II, from Kaiping to Xinhui river water is basically a class or inferior Grade IV, near Haikou officer rushed to reach Class II-III, Jiangmen river water quality class III, day River water quality poor, flood, non-flood season and throughout the year V class of water quality are inferior.

Poor water quality in the Pearl River Delta region as a whole, particularly in the urban area of Guangzhou, Dongguan, Foshan, the most serious, followed by Guangzhou Zengcheng, Guangzhou Panyu, Huadu, Guangzhou, Shunde, Foshan, Shenzhen, once again is Zhuhai, Zhongshan, Jiangmen; Conghua, Guangzhou, Zhaoqing, Huizhou As of March 2010 was slightly better water quality. The most serious water pollution was throughout the Pearl River Basin to the Pearl River Delta region. Increasingly serious water pollution caused by lack of water, has restricted the Pearl River Delta, and is a particularly important factor in the sustainable development of Guangzhou. Pearl of urban sewage treatment facilities is relatively slow, processing capacity is far lagging behind the current industrial and domestic sewage emissions increase speed while due to historical reasons, the old city sewage system is not implemented rain and sewage, urban 19 major rivers acting as Carolina dirt and delivery channel, the PRD organic sources. According to preliminary statistics, the area of industrial pollution are about more than 18,000 enterprises, large, wide, annual pollutants discharged into the Pearl River Pearl River's self-purification capacity greatly exceeds that of water inorganic phosphorus, ammonia nitrogen content increases, heavy metals and organic pollutants aggravate . To GB3838-2002 "Surface Water Quality Standards" standard value limits, the main pollution indicators PRD by pollution

levels were heavier to lighter ammonia, COD, petroleum, TP. Rivers in the Pearl River Delta ammonia, nitrite nitrogen, oil pollution is more serious matter. From the main factor determining the Pearl River pollution is mainly affected by ammonia, nitrite nitrogen, COD, oil pollution, for typical organic pollution.

2.3.2 Water Pollution Sources

The main sources of the Pearl River Delta city are sewage, garbage and feces, waste water plants, sewage irrigated farmland suburbs ingredients containing pesticides and fertilizers, water and land transportation of oil wastewater. Due to various sources, the Pearl River water is mainly affected by pollutants ammonia, nitrite nitrogen, organic matter, oil, volatile phenol, mercury, arsenic, cyanide and hexavalent chromium, which ammonia nitrogen, nitrite nitrogen, organic matter such as oil pollution is more serious, safe drinking water, industrial and agricultural water quality and other residents is undoubtedly a serious threat.

(A) Industrial and domestic pollution

Pearl River Delta and its entire creek are upstream industrial wastewater and domestic sewage. Textile, printing and dyeing, leather, aluminum, paper, food, metal, electroplating and mining high-polluting enterprises cause serious pollution in the Pearl River water quality. Because PRD endangered South China Sea, water transportation is developed, a large number of oil spills and cleaning as well as a small number of ships from industrial wastewater and domestic sewage of oil pollution. Oil is toxic pollutants, and degradation will consume dissolved oxygen, water quality deterioration due to hypoxia. Most of the direct discharge of untreated sewage and increased water pollution in parts of the Delta, especially mercury, chromium and other toxic elements in the water not only polluted river water and river sediment pollution, great risks to human health. In recent years, Guangzhou, Guangzhou and surrounding areas has increased the environmental management and protection, industrial pollution control basically in industrial output increased year by year, while industrial wastewater emissions and emissions of major pollutants decreased.

With the growth of the PRD's population and people's living standards, the sewage emissions have also increased. In the 21st century, the industrial pollution of water pollution in the Pearl River from the past turned to living mainly organic pollution. 2003 Pearl wastewater discharge accounted for 49.7% of the total of the Pearl River Basin sewage and wastewater emissions from this region in recent years have grown. Meanwhile, COD discharge Pearl River also ranks the forefront of the seven rivers, a serious threat to the water quality of the river. According to statistics, every year there is a ship out of Hong Kong, Guangzhou hundreds of thousands of vessels (times), Guangzhou ship dumped into the river every day up to 270 t as much trash per year more than 100,000 t, which also increased the COD discharge basin.

(B) Agricultural non-point source pollution

Agricultural non-point source pollution includes fertilizer pollution, pesticide pollution and intensive farming wastewater pollution. With the rapid growth of population and economy, the Pearl River Delta, under the impact of agricultural pollution of the water environment, has become increasingly evident. Since the region to develop and promote the use of pollution-free vegetables efficiency and low toxicity and residue amount of organ-phosphorus pesticides in recent years, the Pearl River Delta pesticide application rate declined, but it is inseparable from the development of high-yield agricultural chemical fertilizer, fertilizer applied The amount of the rise. According to the area's natural conditions and fertilizer application method, about 21 percent of the agricultural chemical fertilizer into the environment, water, nitrogen is the Pearl River, one of the phosphorus pollution.

III. Proposals for Solutions Improvement

3.1 Solution Proposals for Salt Tides

Climate change, sea level rise and adverse effects on the salt tide intrusion are exacerbated by human activities and take a long and slow process, under the influence of these unfavorable factors, the salt tide in the main threats to the security of water supply the Pearl River Delta will continue to be traced back to the negative direction, is still the main threat to the security of water supply in Guangdong, Hong Kong and Macao. Faced with changes in hydrological regime, the suppression of salty salt tide exacerbates the difficulty increases the grim situation, the urgent need for salt tide is to carry out the evolutionary trend and suppression systems salty prospective study countermeasures for improving integrated water resources management level scheduling and providing technical support to protect the Pearl River Delta and Macao water safety.

3.1.1 Support Efforts to Enhance Science and Technology

Salt tide basic research intrusion law, the power mechanism is to develop and implement measures to suppress the premise and basis salty. In the past ten years, in order to effectively cope with the adverse effects of salt tide intrusion, the related departments carry out a lot of research for the problem of salt tide intrusion in the Pearl River Estuary, but the Pearl River and salt tide are complex problems, many related problems still have not been solved. It is recommended to continue to carry out basic research in the following areas:

(1) Strengthen targeted prototype observation

Pearl River Delta and estuary cross waterways, hydrological, salty complex situation, and by human activities and natural evolution of estuaries and rivers are affected by many factors, they need to grasp the situation salty, salty tide traced research activity patterns and trends for Royal salty, avoid salty and strengthen water management and water intake reasonable arrangements to ensure supply security services to provide a scientific basis. The first recommendation is to strengthen hydrological and

Salty forecast capacity-building, the salt tide forecasting system; the second is in every 5 to 8 years to arrange a delta and estuary underwater topographic survey; and in 3 to 5 years to arrange a dry season and other basic synchronization hydrometric the work.

(2) Strengthen the rule of salt tide intrusion macro and micro mechanism

Estuary salt tide has extremely complex activity patterns by the estuary power and influences their own borders and human activities, including runoff, tides and tide, wind, waves, storm surges, river topography, residual current, near-shore Ocean. It has conducted systematic intrusion research regarding the salt tide macroscopic phenomena and microscopic mechanism of the Pearl River estuary pluralistic dynamic coupling effects, clear wind, wave impact study, sandbar on the salt tide intrusion process mechanism. Pearl River Estuary has been known as a saying "Along with north wind, there must be saltwater", monitoring data and research results in recent years also show that the wind to salt tide intrusion on the Pearl River estuary plays a very important effect, and the response of each entrance to the wind relations is not the same. Yet, as a result of less relevant research, it is unclear in the specific mechanism of actions; estuary sandbar is a unique terrain, traced the influence of salt tide has two sides, their combine the effect for further study; wave is one of the main motivating factors affecting estuarine salt and mixing freshwater; wave - salt transport mechanism is a hot and difficult research under the flow of fresh water coupling.

(3) Strengthen the Pearl River delta salty evolution trend

Based on the research interaction and feedback mechanism between salt tide and influencing factors, it can develop analysis on decomposition and discrimination upstream hydrological regime change, human activities (such as reservoirs, harbors, bridges and other wading construction, dredging, channel dredging), sea season short periodic changes in sea level, climate change under the influence of a long period of rising circulation and influence of the estuary of the Pearl River estuary salt tide intrusion mechanism. Combining changes in the hydrological regime, it can also analyze the characteristics of Pearl River estuary salty changes, main factors, kinetics and mechanism trends. On this basis, it should provide technical supports for the development of long-term suppression of salty measures for the Pearl River Delta and long-term trends in the evolution of salty effective assessment.

(4)Strengthen the overall study on the salt tide intrusion in the Pearl River Delta

Modao Stationis on the coast and there are numerous water intakes of main water source for Zhuhai, Zhongshan and Macao. The salt tide intrusion problem is relatively serious, and more representative. Thus, in previous studies, most of the research results were specific to the salt tide intrusion of Modao Station, relatively few studies on the Pearl River estuary and other waters. In fact, the Pearl River estuary other waters are often affected by the salt tide intrusion. In addition, the dynamic

characteristics of each different station on the Pearl River estuary mouth are diverse; the existing research result of one station cannot simply be transplanted to another one. Therefore, it is necessary to carry out overall and systematic researches on the Pearl River estuary delta and its salt tide intrusion problems in order to strengthen research efforts to other waters.

(5) Strengthen the salt tide dynamic monitoring and early warning research forecasting techniques

Dynamic monitoring and forecasting are the basis of scientific data during the dry season to implement unified Pearl River Basin Water Resources, the methods based on the decision-making are the basis. On the existing basis, it must further strengthen the salt tide dynamic monitoring and early warning research forecasting technology to improve the accuracy of the salt tide dynamic monitoring and forecasting, early warning and forecast prolonged aging, so as to be more accurate, more targeted measures to develop suppression salty provide technical support.

3.1.2 Non-structural Measures on Reducing Salt

(1) Strengthen scientific and technological support to suppress the salty water basin scheduling

Years of practice has proved that the water in the Pearl River Basin is one of the effective measures unified suppression salty, but years of practice also exposed some problems. In the case of unfavorable evolution trend Salty, salty tide goes back under the same flow conditions prolonged, increasing the degree of suppression of salty scheduling more difficult, required suppression salty flow increases year by year; insufficient upstream reservoir storage backbone Year will transfer water shortage occurs, even anhydrous adjustable situation. In the past, suppression salty scheduling practice, due to the complexity of the river delta and the lack of adequate scientific support, cannot be clearly traced salt tide reversed quantitative intensity "peak" salty water pressure response relationship, freshwater resources and therefore cannot be targeted by the tone of their effective pressure flow and pressure salty effect has great uncertainty, precious freshwater resources cannot be efficiently utilized, how to determine the best "water transfer timing" and "water transfer" has always been the problem of decision-making departments feel confused , resulting in suppression of salty water diversion effects of poor controllability and predictability. By strengthening river basin suppression technology support salty water regulation can be effective optimization scheduling scheme, thus reducing the total amount of salty water diversion effect under the same pressure needed to improve the profitability of valuable freshwater resources, freshwater resources to ease the contradiction between supply and demand.

(2) Regional suppression salty scheduling

Pearl River area has complex network of rivers, in addition to the trunk river

confluence of three rivers, eight entrances towards the sea, intertwined, twig growth, the formation of complex and interactive networks outside the United dike around the inside of the trunk, also the river aspect, inland water body and the outer river between the gate "isolation" and "communication." In the same level, they generally have dozens of inland rivers and outside the body, "contact," the gate, thus forming the basis for joint operation of the brake. In addition, in an enclosed internal linking dozens of rivers, generally have one to two rivers as the backbone, the backbone of the width of the river, there was about 100m, depending on the length and depth of different capacities, generally up to a thousand to tens of millions of m3. Inland river channel volume is enormous throughout the Delta region, which is able to use scientific and reasonable dispatch and greatly helpful for the hazard mitigation and effects of the salt tide.

The main scientific and technological issues for regional dispatch inhibit salt tide include: embedded gate area group scheduling technology and dual access water allocation model; Gate area group scheduling simulation technology; linear programming optimization based on regional scheduling technology; gate area based on neural network swarm optimization scheduling technology; gate area group scheduling system integration and optimization.

(3) Improve the implementation of relevant laws and regulations

To implement the strictest water management system, the key is to continue to improve and implement a comprehensive water management laws and regulations, thoroughly implement the water management system, delineation of water resources management "three red lines" and strictly enforce the law supervision. Even there has relatively abundant water resources, but this is uneven for the distribution of the Pearl River Basin. It is critical for water management to implement the strategy of the implementation of targeted methods and measures according to local conditions. Water supply and demand for the Pearl River Valley during the dry season of the problems must be developed as soon as possible. "The Pearl River Water Regulation" must strengthen the management of water resources allocation, optimize the scheduling scheme, improve scheduling management system, improve scheduling mechanism to improve the ability to protect the water supply, better implement the strictest water management system to protect urban and rural life, production and ecological water demand in the Pearl River Basin to achieve optimal allocation of water resources and sustainable use.

Development of "Pearl River Water Regulating" reinforces the unified management of basin water resources, establishes authority, and coordinates the efficient integrated water resources scheduling to form a new model of unified management. It is also conducive to promote different regions and industries in the upstream to achieve a maximum overall efficiency of construction projects. It will also help to coordinate the various sectors and industries as well as the interests and conflicts between upstream and downstream to ensure the safety and security of water

supply watershed flood control and to promote sustainable economic and social development of river basin.

3.1.3 Construction Works for Salt Reduction

It is recommended to establish a rational and efficient allocation of water resources and water supply security system, focusing on promoting the West River water diversion projects in Guangzhou, Zhuhai Water Storage silver bamboo water and other places.

Datengxia Hydro controls the West River runoff, with the construction of the West Jiang Changzhou joint use of hydropower, water one day scheduling process to reach the Pearl River Delta, with a runoff flexible compensation adjustment capacity to meet the West River and the Pearl River Estuary ecological flow pressure salty flow requirements for the protection of the West River, Macau and the Northwest River water safety plays an important role. Recommendations for parties are to work together to accelerate the Datengxia project construction work.

3.2 Solution Proposals for Disaster Control

3.2.1 Accelerating the Construction of Datengxia Project

The efforts are to conduct preliminary survey and design work for Datengxia Project, further optimize the project of flood control scheduling scheme, in-depth demonstration flood control capacity of the scale of the project, reduce the normal submerge, eliminate or minimize over storage affect measures flood period and promote the building of the West River flood control system.

3.2.2 Strengthening the Management of Flood

Founded Pearl River Flood Control and Drought Relief Headquarters can strengthen the legal system construction of flood control basin management, increase flood management efforts; to carry the West River, North River, East River and the Liujiang River, the main tributary of the West River Yujiang controlling reservoir and other research programs using joint scheduling; active Pearl River flood way arrangement, from passive to active defense flood; construction work to accelerate the development of the Pearl River flood control command system, continue to improve the information collection system, including meteorological product applications, including decision support systems, with emphasis on the completion of the Flood Control System construction of flood forecasting systems and disaster assessment system.

3.2.3 Strengthening Basic Research and Thematic Studies

Rapid economic and social development in the Pearl River basin, water, engineering conditions vary widely, should strengthen basic information accumulated work, key projects planned way, focusing on the river, the Pearl River Delta and estuary conduct

underwater topography; hydrological synchronization test, to grasp the changes in flood; flood survey conducted master flood characteristics and features of floods.

According to the general characteristics and flood control works Flood layout, combined with economic and social development, flood control district to carry out flood risk analysis of flood risk analysis and assessment indicators, the preparation of flood risk maps. Thematic studies West River, North River, East River and its tributaries water conservancy and hydropower project impact on downstream flood control scheduling scheme, the preparation of major rivers flood control operation plans.

It analyzed the impact of the floods due to human activities. Floods went through the new Pearl recent case, the focus should be studied, and the effect of flooding downstream areas owned by groove; urbanization will lead directly to the flood runoff produced, convergence conditions change, you should study the hydrological effects on the regional flood control , drainage impact; as the global warming trend, extreme weather events have increased tendency to strengthen collaboration with the meteorological department, the study of climate change, sea level rise and coastal erosion on soil erosion control, mountain flood prevention and the impact of flood control basin.

3.2.4 Developing of Urban Planning and Standards on Flood

Urban waterlogging governance is not only a problem of urban drainage network construction, and is a matter of sustainable urban development, systems engineering, and urban run urban ecological security, governance waterlogging must be taken into account in urban planning, urban construction and management levels. Only by adhering to the scientific concept of development, with a scientific, long-term vision to plan, design, construction and management of urban, in order to eliminate hidden dangers fundamentally waterlogging.

Any city drainage measures are only a certain degree of waterlogging defense under certain economic, technical support. Whatever develop defense standard, theoretically there circumstances beyond defense standard may occur. Standard too high, not only uneconomical, but it is impossible to be fully implemented; on the contrary, if the lower design standards, the greater the likelihood of the city flooded, the probability of huge losses of life and property is higher. So, how to find a reasonable balance between high standards and investment returns, whether direct impact on the development of a scientific and rational defense standards. Need to carry out appropriate research topics were discussed.

3.2.5 Strengthening Hazard Warning and Emergency Response Capacity Building Measures

Disaster warning, forecasting non-engineering measures and emergency response system is an important part of urban disaster prevention system, and it is an

important part of flood defense, should be given adequate attention.

3.3 Solution Proposals for Water Pollution

3.3.1 Technical Support

Pearl River estuary tidal river mostly on inland runoff dominated by lower tidal backwater, water flow was unsteady complex periodic reciprocating flow easily accumulate pollutants in the Pearl River estuary area, leading to the deterioration of water ecology ecological function degradation, in this dynamic process, many important physical, chemical and biological characteristics of the Pearl River Estuary have the particularity of water, forming a complex structure, and function of many factors unique ecosystem. Therefore, migration and transformation of pollutants in complex estuarine hydrodynamic conditions and its impact on the water environment evolution mechanism estuarine water is hot and difficult environmental and ecological research. Conduct appropriate research for the establishment of water environment monitoring system, scientific management measures to develop water quality objectives and adequate and safe water environment capacity utilization waters provide strong technical support.

3.3.2 Governance and Policy Support

(A) Strengthen environmental awareness increase citizen awareness of environmental protection

Water protection is the cause of the relationship between development and progress of society as a whole, involving thousands of families, the region should join hands vigorously calling for social protection of water environment, strengthen mutual supervision of administrative regions, the public media public opinion, public supervision, to ensure that the Pearl River Delta water ongoing conservation work. While further raise environmental awareness on environmental issues so that those who do not lose as corporate social image, reducing the value of its intangible assets. Thus, by the popularity of the public knowledge of environmental health, and greatly enhance environmental awareness of citizens in the basin, the public play a supervisory force, prompting industrial companies disclose environmental information, change the corporate and public corporate environmental behavior pattern of asymmetric information, ensure public information and participation, which enables companies to establish a good image of the initiative to improve their environmental behavior.

(B) Improve and regulations, strengthen law enforcement

"Water Law", "Environmental Protection Law", "Water Pollution Control Act" and other laws and regulations have played a fundamental role in the protection of water resources in the past, but this is not enough, the central and local should be with the times, constantly improve relevant laws and regulations. But it also can strengthen

law enforcement, and strengthen environmental supervision and management, to crack down on illegal polluters. Establish a long-term deal with oversight mechanisms, including routine check water quality supervision, monitoring, and pollution emissions timely inquiries system, accountability pollution emergency, as well as government officials of the executive accountability, unified management of watersheds. Implementation of quality of water supply and water resources fee reform measures in the appropriate areas.

(C) Improve the drainage network system to improve sewage treatment capacity

Gradually improve the sewage treatment plant upstream projects - sewerage system, through the improvement of the sewerage system to reduce the amount of pollutants discharged into the surrounding rivers, so that economic development and population, resources, and environmental development. Chief Executives to implement accountability, on the one hand pollution, the pollution implement; the one hand and urban sewage treatment plant construction and operation of the market mechanism to establish sewage treatment enterprise, market-oriented and investment operations as soon as possible.

(D) Strengthen the control of pollution sources

Pollution source control is the most fundamental measures to control pollution. The main source control is the implementation of cleaner production, such as the use of toxic and harmless raw materials, production equipment and technology improvements, construction of water recycling equipment to reduce emissions, such as sewage. Agricultural nonpoint source pollution control rational use of fertilizers, reducing pesticide use, while good jobs of sewage treatment scale livestock farms.

(E) Improve watershed management integration

Integrated watershed management activities are often limited to the administrative divisions; people rarely consider the water environment beyond the boundaries. But water pollution have taken place within the natural boundaries of watersheds, but not limited to administrative boundaries. Catchment area of the river basin, which reflects the geographic characteristics and distribution of water resources development and utilization of water flow, determines the water is pooling basin as a unit, excretion carrier. Holistic watershed is extremely high correlation of the region, the basin upstream of human activities will eventually have an impact on the downstream. Therefore, for the river, the river basin is the logical management unit, rather than the administrative area.

Water pollution control for the PRD, should strengthen regional cooperation (including the different provinces on watershed, city, town) between, including cooperation and collaboration with the clinical area, between neighboring provinces and Hong Kong and Macao, in order to prevent cross-regional pollution problems and disputes occur. From the overall interests of the entire basin of view, the overall

arrangement, so the comprehensive improvement of water environment in order to achieve results. Pearl River Water Resources Committee of the whole river basin can make global governance considerations and to avoid the various administrative areas fragmented, uncoordinated, avoid friction, improve efficiency, but also to avoid the local protection behavior.

3.3.3 Infrastructural Support

(A) Accelerate the construction of water environment

Water Project water to flush out pollutants, including engineering, dredging project and other projects. Diversion of river pollution project can adjust the water flow, increase impulse sewage, and improve self-purification capacity of water bodies. Because part of the Pearl River Delta has been seriously polluted river sediment heavy metals and organic compounds, alone control emissions and increasing water flow is difficult to fundamentally improve the water quality. Therefore, you must also take measures to dredging project, the perennial bed in the accumulated sludge removal, but also to remove the serious pollution of heavy metals and organic sediment, water quality suffers avoid secondary pollution. Dredging project must be environmentally feasible, to avoid disturbing the sediment accumulation which will be converted to perennial heavy metals in water, causing accidents.

(B) Accelerate bioremediation construction

Pearl River Basin due to population pressure increases, people, places tensions led to over-exploitation of river basin lakes, wetlands shrinking forest cover decreased, the ecological environment has deteriorated severely restricted the basin economy. Therefore, we must build a protective barrier Pearl ecological flows of the city, increasing the river upstream forest vegetation cover, strengthen the comprehensive management, and prevent soil erosion.

The construction of the plant quarantine zone is a way to reduce pollutants into surface water migration. Plant quarantine with better environmental benefits and economic benefits, it is not only because the plant quarantine zone to prevent soil erosion and increased runoff infiltration, interception through the use of nutrients, reducing the discharge of pollutants into surface water bodies and improve the habitat, making all kinds of shore organisms to growth and reproduction. US National Nature Conservation Association recommends shore flora into three bands, can get a good repair results, we recommend using the flood land to build a plant quarantine zone, the pollutants discharged into the river before the buffer role played interception.

Construction of wetlands is also an effective way to purify the river. Wetland construction, to improve the water quality of the Pearl River to play "artificial kidney" role, plays a green building "artificial lung" role, which is to improve the PRD regional climate and atmospheric environment is very important. Surface water from flowing

through the wetland system, oxygen diffusion through the water supply, solubility and root contact with the system media particulate pollutants contained in the water and plants, common cattail reed plants, arrowhead, sedges and so on. Wetland good for BOD, COD, SS, heavy metals and other contaminants removal, and there is little stench and breeding mosquitoes phenomenon. It is recommended for polluted river in situ construction, ectopic and different ways of wetland water distribution system for water purification. Meanwhile, the contaminated water flows into some microbes decompose organic matter, or in the polluted river and plants some heavy metal enrichment plants, they can be combined with the application of artificial wetland system to further improve water quality.

In addition, you can also build a buffer forest to sluggish settling sediment runoff, strengthen and enhance the adsorption filter to reduce the concentration of water pollutants. Floating island and caisson biological and ecological co-processing systems, floating rafts, increasing river Wu Tong and coastal wetlands and ecosystem services are all effective in improving the environmental quality of the river water technology.

(C) Accelerate the construction of public works

To reduce urban sewage discharge into the river, we must accelerate the pace of construction of urban sewage collection and treatment systems, sewage treatment plant improvement and matching sewage pipe network, improve distribution network coverage. Chung old city is along the river to intercept sewage pipe laid interception; it can implement new city rain and sewage; emphasis on promoting the use of municipal water-saving facilities and structures. In addition, due to the high concentration of sewage treatment plant emissions of nitrogen and phosphorus in the tail water and sludge, it may contain traces of hazardous pollutants to the water discharge mud and sludge emissions also contains a lot of water environment unfavorable substances, therefore, it also must be strengthened to deal with water and sewage treatment plant tail water and sludge.