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THE CHARACTERISTIC OF MARINE ENVIRONMENT IN LINGDINGYANG ESTUARY

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ABSTRACT: Hydrologic features, load of main pollutants and current condition of water quality in Lingdingyang Estuary are discussed by references and monitoring data. Affected by topography, runoff and tide, its dynamic condition is very complicated. Different water areas have different hydrologic features. The topography under the water of Lingdingyang Estuary is higher in the northwest than that in the southeast. The shoal alternates with the deep trough within the bay . The distribution of the salinity and the contents of the mud and the main pollutants tally with the topography tendency. Change in water quality goes through four stages. Current condition of water quality is fairly good. Inorganic nitrogen is the primary pollutant, and then phosphorus. Rich in nutrition of nitrogen and phosphorus become a more and more prominent problem.

KEY WORDS: Lingdingyang Estuary; hydrologic features; load of pollutant; water quantity

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1 HYDROLOGIC FEATURES

Lingdingyang Estuary, located at the middle south of Guangdong Province, is a bell-shaped estuary with a north-south direction. Its area is about 2100km^2. The north of Qi'ao Island and Inner-Lingding Island, and the south of Humen are grouped as Neilingdingyang Estuary, having an area of 1041km^2. Affected by topography, runoff and tide, its dynamic condition is very complicated. Different water areas have different hydrologic features. The topography under the water of Lingdingyang Estuary is higher in the northwest than that in the southeast. The shoal alternates with the deep trough within the bay. From west to east, there are the west shoal, named as Lingding course, the middle shoal (Fanshi shoal), named as Fanshi course and the east shoal. Thus, a structure of a three-shoal and a two-deep-trough is formed for the under-water topography. Within the estuary, there are lots of small islands, such as Shanbanzhou, Dachan, Xiaochan, inner-Lingding and Qi'ao islands. The Zhujiang (Pearl) River flows into the bay via eight different outlets. Four of them, namely Humen, Jiaomen, Hongqili and Henmen are in Lingdingyang Estuary. The average discharge of the stream flow to Lingdingyang Estuary is about 5 663m^3/s and the total runoff amount is 174.2 × 10^{9}m^3/a, comprising 53.4% of the total amount of the flow of Zhujiang River to the sea . The details are listed in Table 1.

The Zhujiang(Pearl) River Estuary is a weak tide one with irregular half-day tide, i. e., two high tides and two low tides occur alternatively in a day and the tide period varies frequently. The average tide range is less than 2m. The average flood-tide flow is 73 500m^3/s per

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Table 1 Amount of runoff, sand transfusion and average tide range of Humen, Jiaomen, Hongqili and Henmen

Feature	Humen	Jiaomen	Hongqili	Hengmen
Runoff($10^8m^3/a$)	603	565	309	365
% of total	34.6	32.4	12.0	21.0
Sand-transfusion($10^4t/a$)	658	1289	517	925
% of total	19.4	38.0	15.3	27.3
Average tide range(m)	1.65	1.36	1.21	1.11
Maximum tide range(m)	3.39	2.81	2.79	2.48
Runoff/tide *	0.51	3.32	4.12	5.26

* runoff/tide = 2 × runoff/flood-tide flow rate.

tide and the average incoming tide amounts to $1.462 \times 10^9m^3$ per tide. The amount of water-transfusion per unit width in ebb-tide period is larger than that in the flood-tide period(LUO *et al.*, 1992). The features of Lingding Estuary are presented in Table 2.

Table 2 The tidal features of Lingdingyang Estuary

Feature	Shanbanzhou	Chiwan	Inner-Lingding Island
Average tide range (m)	1.61	1.37	1.30
Maximum tide range of flood-tide (m)	3.17	2.47	
Maximum tide range of ebb-tide (m)	3.58	3.44	3.05
Average lasting time of flood-tide(h)	6.75	6.75	
Average lasting time of ebb-tide(h)	6.73	6.73	
Years	19	19	

The tide-range of Lingdingyang Estuary is low at the mouth of bay, high near the top of bay, but decreasing at the upstream. According to their tide features, the four largest mouths, namely Jiaomen, Hongqili, Henmen, and Humen, are divided into two types. The tide-range for the former three mouths is only 1.0 – 1.5m, their annual runoff is 65.4% of the total runoff of Lingdingyang Estuary, and the flood-tide amount is only 18.9% of the total amount. Thus for those mouths, the river runoff plays an important role. For the latter, the tide-range is 1.63m, its annual runoff is 23.6% of the total runoff of Lingdingyang Estuary, but the flood tide amount is 81.1% of the total runoff. Thus for this mouth, the tide plays an important role. The tide is basically a reciprocating flow along the direction of the slotting beach. Generally, the flow rate of the ebb tide is greater than that of the flood tide. The flow rate of the flood tide in the dry season is greater than that of the flood season, whereas for the flow rate of the ebb tide, the situation is just the opposite. The distribution of the flow rate is influenced greatly by the under water topography.

The flow rates of the ebb tide and flood tide for deep slot are greater than those for the shallow beach. The characteristic values for the tide, observed from the field, are presented in Table 3. In the flood season, the interface of the tidal area of the Zhujiang River main flow appears in the vicinity of Laoya Island, the interface of the tidal current is within the Shiwei Tang and Huangpu areas, while the interface of the salt-water is within the Xiya and Xiaochan Islands which are in the east of Lingdingyang Estuary. In the dry season, the interface of the tidal area moves up within Laoya Island and Jiangcong, while the interface of salt-water moves to the vicinity of Huangpu (LUO *et al.*, 1992).

Table 3 Characteristic values of the tide of Lingdingyang Estuary

Section	Maximum rate(m/s)		Maximum tide discharge(m^3/s)		Maximum total tide runoff(10^4m^3)	
	Flood tide	Ebb tide	Flood tide	Ebb tide	Flood tide	Ebb tide
Humen	1.12	1.01	42500	34300	54660	74120
Jingxinmen	0.99	1.37	184600	185700	238950	345430

The main power resources of Lingdingyang Estuary come from the tidal current, which is strong in the east but weak in the west with a reciprocating feature. Within the Inner-Lingding Estuary, the tide moves mainly in the NNW-SSE direction, but turns to S-N direction at Out-Lingdingyang Estuary. Outside of the Humen waterway, the stream flow divides into east and west branches named as Fanshi waterway and Lingding waterway respectively.

The tidal current in the east branch is stronger than that in the west branch. For the same cross-section, the ebb-tide rate in the east branch is higher than that in the west branch by 0.15 – 0.25m/s.

Influenced by the runoff merging from the mouths of the northwest Lingdingyang Estuary, the water surface of Lingding Estuary has a decreased cross-range from west to east. It can reach up to 50 – 70cm when the tide is ebbing abruptly. The cross range is relatively small when the tide is flowing rapidly, but generally, the water level near the western coast is still higher.

Due to the decrease of the cross range of water surface, the fresh water diffuses from northwest to southeast. The high-density salt water usually controls the south section of Lingding waterway and the Ansitong waterway. This salt water flows upstream to inner-Lingding Island and Xixiang through the two waterways mentioned above, forming a wide range of mixed area of salt and fresh water. The isopleth of the salt degree is along the NE-SE direction (TAN *et al.*, 1993).

A muddy band forms in the mixed area of salt and fresh water. In the flood season, such muddy band usually forms in the sea area having a salinity of 3 – 10. The content of the mud can be as high as 1.28 – 1.59g/m^3, approximately 8 – 10 times of the usual mud content. During the dry season, the mud band forms in the sea area having a salinity of 16 – 22, the mud content is usually 0.6kg/m^3, about 3 – 5 times of the usual content. The greatest muddy band within a tide cycle ranges from 2km to 5km, and the seasonal varying range is from 8km to 13km (LUO *et al.* 1992).

2 LOAD OF MAIN POLLUTANTS

In the 1980s, a number of units have monitored the runoff and concentration of pollutants, and have estimated the load of some of the major pollutants. But owing to the difference in monitoring time, location and periods, the results varied from one to another. Table 4, 5 and 6 listed the data obtained from the Committee for the Zhujiang River Water Resources Conservation in 1985 – 1987. The COD load was about 2.18 × 10^{5}t/a, the inorganic nitrogen 1.63 × 10^{5}t/a, and the TP 1.23 × 10^{4}t/a. Zhongshan University predicted that by the year of 2000, the COD load would be about 4.88 × 10^{5}t/a, the TN 2.63 × 10^{5}t/a, and the TP 2.01 × 10^{4}t/a.

The load of pollutants discharged from Humen into Lingdingyang Estuary was highest, while that from Hongqili to Lingdingyang Estuary the least, as shown in Table 4 – 6. Of all the pollutants, the COD has the highest load, the next are TN, oil and TP respectively (PENG *et al.*, 1991; 1994). LIN reported in 1985 that the loads of inorganic nitrogen (ION), PO_4^{3-} – P, SiO_3^- – Si discharged from Humen into Lingdingyang Estuary were 3.61kg/s, 0.07kg/s and 10.5kg/s respectively, while those discharged from the Zhujiang River mouth into the sea were 5.95 × 10^{4}t/a, 0.74 × 10^{4}t/a, and 22.8 × 10^{4}t/a, respectively (LIN,

Table 4 Loads of COD & ION through Humen, Jiaomen, Hongqili and Hengmen in 1985 – 1987 (t/a)

	Humen		Jiaomen		Hongqili		Hengmen	
	COD	ION	COD	ION	COD	ION	COD	ION
Total	82985.61	57691.0	60895.8	52572.05	29202.23	19204.4	44503.1	33613.3

ION: inorganic nitrogen

Table 5 Loads of heavy metals, oil and discharge into the sea (t/a)

	Hg	Cu	Pb	Zn	Cd	Oil	ON
Humen	1.08	307.1	94.04	6510.0	32.99	12010.0	138.25
Jiaomen	2.74	255.9	948.90	1871.0	28.79	11590.0	187.41
Hongqili	0.73	129.3	139.50	670.8	21.31	2663.0	61.69
Hengmen	0.87	412.6	200.90	1253.0	16.59	5003.5	108.67
Total	5.42	1104.9	2229.70	10304.8	99.68	31266.5	496.02

ON: organic nitrogen

Table 6 Concentration and loads of TN and TP discharge into the sea

	Humen	Jiaomen	Hongqili	Hengmen	Total
Flow (10^{8}m^3/a)	577.98	541.46	200.10	350.52	1670.06
TN content (mg/L)	2.042	1.448	1.349	1.496	
TN load (10^{4}t/a)	11.80	7.84	2.70	5.24	27.58
TP content (mg/L)	0.070	0.087	0.065	0.062	
TP load (10^{4}t/a)	0.41	0.47	0.13	0.22	1.23

1985).

3 CHANGE OF WATER QUALITY

According to the historic data and the result obtained by professional survey team of the Zhujiang River mouth seashore pollution in March and August of 1981 (19 stations in Lingdingyang Estuary, Fig. 1a), the average contents of the Zhujiang River mouth seashore pollutants at the end of 1970s and the beginning of 1980s are shown in Table 7 (ZHOU, 1994) . First pollutant was oil, then volatilizing phenol and organic chlorine pesticide. The oil content from 1977 to 1979 were low, from 0.036 to 0.059mg/L, but high in 1980 and 1981, which were 0.103 and 0.121mg/L, which exceeded 4th criterion about seawater quality of China (GB3097 - 1997, the same as follows). Phenol and HCH(hexachloro cyclo-hexane) slightly exceeded grade 1, DDT grade 2. Without surveying nitrogen and phosphorous, organic pollutant COD was lower, which was 2mg/L in north, 0.65mg/L in middle part, average 0.85 mg/L. Heavy mental lead and Zn are exceed grade 1 and 2, respectively. Cu is beyond of grade 2 in 1980.

By item of Chinese "Seventh Five-year" science and technology study, evaluating water status and forecasting discharged load of pollutants in Lingding Estuary, such as COD, TN and TP, the survey result on July 16 - 17 in 1988 is shown in Table 8(15 survey stations, as Fig. 1b) . The contents of organic pollutants, phosphate and COD apparent were increasing. Average phosphate content was in grade 2, 0.03mg/L. COD was 2.4mg/L (exceed grade 1) . ·ION is 0.11mg/L (exceed grade 1 in flood tide). Oil in 0 - 10cm, 50cm

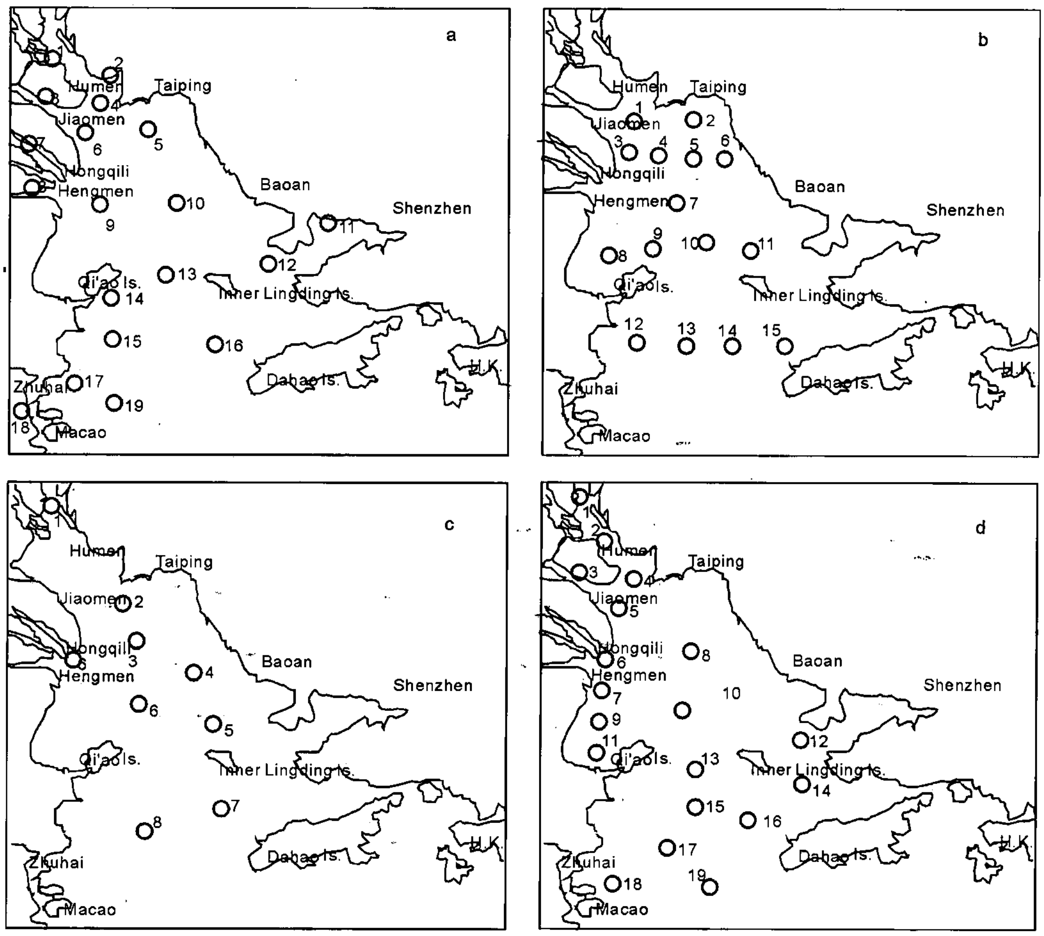

Fig. 1 Distribution of monitoring stations

Table 7 Monitoring results of 1977 - 1981 in marine of Zhujiang River mouth(mg/L)

		Hg*	Cu	Pb	Zn	Cd	Oil	COD	DDT	HCH
1977	0.022	0.0032	0.043	0.0161	0.0014	0.042	0.0015	0.76		0.00058
1978	0.023	0.0053		0.0382		0.059	0.0010	0.65	0.00013	0.00097
1979	0.036	0.004	0.008	0.0146	0.0003	0.036		1.07	0.00013	0.00108
1980	0.018	0.0141	0.007	0.0416	0.0001	0.103	0.0031	0.65	0.00006	0.00020
1981	0.024	0.005	0.009	0.0480	0.0010	0.121	0.0058	0.87	0.00039	0.00124

* The unit for Hg is μg/L.

and bottom are 0.110mg/L (exceed grade 3), 0.061mg/L and 0.039mg/L in flood tide, 0.041 mg/L, 0.030mg/L and 0.019mg/L in ebb tide, respectively, average is 0.05mg/L, grade 1. Mental Pb and Zn are higher as before, beyond of grade 2 and 1. Hg is beyond of grade 1 too.

By the report, 3 and 5 stations in north and south district of Lingdingyang Estuary were set up, monitoring was conducted in March, July and Oct. of 1993. The results (Fig. 1c, Table 9) show that COD, oil, ION & IOP contents are 2.1mg/L, 0.078mg/L, 0.824mg/L and 0.021mg/L respectively (ZHOU, 1994). COD exceeds the grade 1, oil is beyond of the 2nd criterion, ION is beyond of the 4th criterion, and Hg is over grade 1.

The Environmental Survey Center of South Marine, Ocean Bureau of China, and the Environment Institute of Zhongshan University set up 19 stations (Fig. 1d) from new harbor of Huangpu to Guishan Island on July 15, 1996 (each mouth has one station, west shoal four, Lingdingyang Estuary 12), and sampled in flood tide and ebb tide. The result is shown in Table 10. It indicates that ION of surface layer were changed from 0.112mg/L to 1.103mg/L in flood tide and from 0.108mg/L to 1.03mg/L in ebb tide, ION of bottom from 0.092mg/L to 1.255mg/L in flood tide and from 0.112mg/L to 1.103mg/L in ebb tide. Its surface and bottom average contents were 0.561mg/L and 0.527mg/L, the rate of exceed criterion was 77.1% in flood tide, and 0.533mg/L and 0.402 mg/L, 85.7% in ebb tide. The average ION of all tide was 0.506mg/L, exceeding grade 4. Labile-phosphate was 0.023mg/L, exceeding grade 1. COD and oil are 1.82mg/L and 0.039mg/L, respectively, lower than that in 1988 and 1993. It shows the elementary effect of preventing pollution of the Zhujiang River delta. Organic pollutants

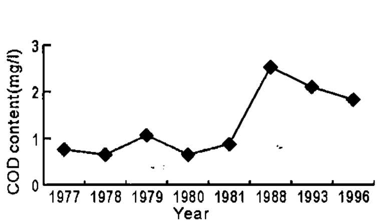

Fig. 2 Curve of COD content variation

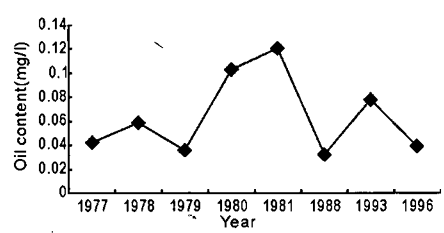

Fig. 3 Curve of oil content variation

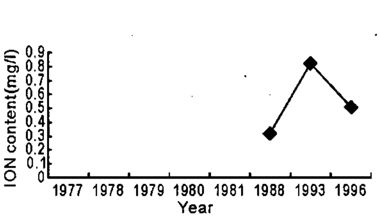

Fig. 4 Curve of ION content variation

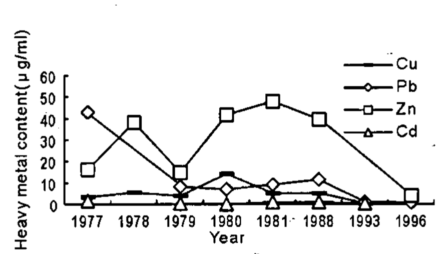

Fig. 5 Curve of mental content variation

Table 8 Monitoring results of 1988(mg/L)

Station	Time	Cl^-	Oil	COD	Cu	Pb	Zn	Cd	IOP	NH_3-N	NO_2-N	NO_3-N **
1	HD*	355	0.056	2.48	2.21	7.98	68.9	-	0.036	0.133	0.006	0.054
	HH	402	0.058	2.48	-	9.64	33.3	-	0.029	0.114	0.008	0.054
	DD	52	0.038	2.72	3.50	19.6	84.5	-	0.009	0.110	0.007	0.109
	DH	679	0.019	2.96	6.73	14.6	83.7	-	0.027	0.290	0.009	0.023
2	HD	94	0.063	2.34	1.99	16.3	60.3	0.32	0.057	0.126	0.008	0.056
	HH	118	0.042	2.32	1.13	27.8	34.8	-	0.073	0.258	0.009	0.033
	DD	487	0.017	2.76	1.13	11.3	40.2	-	0.025	0.084	0.010	0.040
	DH	818	0.025	3.84	7.81	17.9	36.4	0.32	0.016	0.245	0.008	0.064
3	HD	700	0.032	2.00	1.13	11.3	30.9	-	0.017	0.161	0.007	0.053
	HH	922	0.032	2.16	-	6.32	37.9	-	0.019	0.142	0.011	0.072
	DD	54	0.014	3.92	14.7	21.2	62.8	0.32	0.049	0.090	0.007	0.186
	DH	1036	0.007	4.12	9.75	22.9	43.3	-	0.070	0.084	0.009	0.093
	HD	976	0.141	1.76	-	4.67	30.9	-	0.029	0.226	0.008	0.182
4	HH	2735	0.035	2.04	5.44	4.67	34.0	0.32	0.026	0.258	0.013	0.106
	DD	307	0.037	2.40	-	1.36	0.65	-	0.068	0.084	0.009	0.243
	DH	2235	0.009	4.56	9.96	16.3	49.6	-	0.058	0.258	0.012	0.136
5	HD	1050	0.045	2.08	-	4.67	50.3	-	0.025	0.226	0.010	0.082
	HH	2415	0.040	1.86	-	3.02	34.8	0.32	0.021	0.206	0.013	0.145
	DD	133	0.088	2.16	-	-	-	-	0.032	0.206	0.005	0.059
	DH	1140	0.012	2.40	-	-	-	-	-	0.155	0.005	0.050
6	HD	1135	0.045	2.18	-	7.98	65.1	-	0.042	-	0.006	0.173
	HH	2382	0.026	3.12	2.64	12.9	34.0	-	0.042	-	0.007	0.175
	DD	234	0.014	2.88	-	-	-	-	0.030	0.077	0.005	0.068
	DH	1617	0.008	6.80	-	-	-	-	-	0.258	0.005	0.052
7	HD	2445	0.048	1.96	-	11.3	23.2	-	0.036	-	0.005	0.205
	HH	4690	0.025	1.88	-	11.3	40.2	-	0.025	-	0.005	0.147
	DD	1890	0.010	1.96	-	12.9	38.7	-	0.045	0.161	0.005	0.098
	DH	2295	0.007	3.52	8.24	24.5	31.2	4.00	0.046	0.168	0.005	0.208
8	HD	5965	0.044	2.12	-	7.98	45.7	-	0.025	0.064	0.006	0.169
	HH	13820	0.050	1.52	-	6.33	33.3	-	0.015	0.116	0.007	0.195
	DD	2105	0.014	1.96	-	3.02	41.8	-	0.027	0.226	0.008	0.102
	DH	12095	0.005	2.24	1.99	11.3	58.9	-	0.050	0.206	0.008	0.159
9	HD	6920	0.087	1.72	-	4.66	46.5	0.32	0.042	0.097	0.008	0.251
	HH	16370	0.015	2.68	4.79	12.9	58.9	-	0.045	0.123	0.008	0.067
	DD	2350	0.028	2.32	-	3.03	26.3	-	0.011	0.161	0.008	0.193
	DH	12515	0.010	2.96	3.93	9.64	45.7	0.32	0.043	0.181	0.007	0.158
10	HD	4085	0.033	2.40	-	9.64	41.0	-	0.049	-	0.008	0.188
	HH	15880	0.016	3.36	4.79	16.3	45.7	-	0.040	-	0.008	0.224
	DD	4995	0.015	2.66	3.50	7.98	49.6	4.00	0.020	-	0.008	0.245
	DH	10285	0.009	3.68	5.22	9.64	44.9	-	0.048	-	0.006	0.084
11	HD	13715	0.037	2.12	-	9.64	41.0	-	0.016	0.116	0.008	0.128
	HH	22160	0.021	1.76	-	*	29.4	-	0.018	0.155	0.006	0.160
	DD	9250	0.024	2.06	-	4.67	31.7	4.00	0.022	0.206	0.007	0.230
	DH	18040	0.025	2.68	1.78	3.03	58.9	0.32	0.047	0.219	0.007	0.188
12	HD	13715	0.031	2.40	-	7.96	31.7	-	0.030	0.142	0.005	0.368
	HH	22160	0.014	2.00	-	7.98	27.0	0.32	0.023	0.226	0.005	0.270
	DD	9250	0.034	2.16	-	6.32	27.8	-	0.012	0.200	0.006	0.240
	DH	18040	0.012	2.68	-	3.02	19.3	-	0.030	0.135	0.006	0.200
13	HD	13715	0.063	2.00	-	17.9	24.7	0.4	0.015	0.206	0.008	0.113
	HH	22160	0.010	1.92	2.21	22.9	30.9	-	0.017	0.226	0.006	0.148
	DD	9250	0.032	2.16	-	7.98	53.4	-	0.022	0.052	0.008	0.130
	DH	11840	0.013	4.73	7.81	12.9	25.5	0.32	0.005	0.206	0.006	0.202
14	HD	11560	0.113	1.48	-	7.98	26.3	0.40	0.015	0.161	0.005	0.185
	HH	18680	0.031	1.20	-	11.3	32.5	0.40	0.011	0.181	0.006	0.153
	DD	8430	0.035	2.36	-	24.5	42.6	-	0.012	0.116	0.005	0.154
	DH	18570	0.028	3.52	9.32	29.5	23.9	0.48	0.027	0.219	0.005	0.130
15	HD	13715	0.034	1.60	-	11.2	24.7	0.40	0.010	0.084	0.004	0.167
	HH	22160	0.027	1.36	-	9.64	19.3	0.56	0.022	0.116	0.004	0.146
	DD	9250	0.015	2.16	-	14.6	27.0	0.48	0.016	0.110	0.005	0.160
	DH	18040	0.029	1.88	-	11.2	39.7	-	0.032	0.135	0.005	0.148
Average		7511	0.032	2.53	5.07	0.92		0.92	0.031	0.164	0.007	0.144

*H: high tide, D: low tide; ** ION = NH_3-N + NO_2-N + NO_3-N ; " - "express not check out.

Table 9 Monitoring results of 1993

		Area I				Area II			
		Mar.	July	Oct.	Aver.	Mar.	July	Oct.	Aver.
DO(mg/L)	min.	3.66	6.11	2.07	-	6.77	5.20	5.16	-
	aver.	5.67	6.28	4.07	5.34	7.09	6.52	6.07	6.57
COD(mg/L)	max.	4.67	2.65	3.63	-	2.40	2.53	2.07	-
	aver.	4.12	2.18	2.37	2.89	1.10	1.72	1.11	1.31
pH	max.	7.80	7.92	7.81	-	8.16	8.08	8.04	-
	aver.	7.42	7.80	7.47	7.56	8.17	7.97	7.98	8.01
Oil(mg/L)	max.	141.0	76.0	150.0	-	143.0	506.0	174.0	-
	aver.	107.0	45.5	86.0	79.5	65.2	98.4	68.1	77.2
IOP(μg/L)	max.	21.8	28.0	20.8	-	32.6	30.1	29.4	-
	aver.	18.2	21.4	17.7	19.1	25.6	20.5	20.9	22.4
ION(μg/L)	max.	1392.8	851.8	1186.2	-	810.6	965.4	956.6	-
	aver.	1097.6	812.5	1161.7	1023.9	464.3	321.7	584.6	623.5
Hg(μg/L)	max.		0.47		0.47		0.33		0.33
	aver.		0.12		0.12		0.10		0.10
Cu(μg/L)	max.		3.1		3.1		0.0		0.0
	aver.		0.38		0.38		0.0		0.0
Lead(μg/L)	max.		1.80		1.80		3.30		3.30
	aver.		0.87		0.87		0.84		0.84
Cd(μg/L)	max.		4.00		4.00		0.80		0.80
	aver.		0.67		0.67		0.07		0.07

got fringe control. However, the pollution of N and P became more and more standout. The continual red-tide make out the problem.

Sum up above states, there are four stages of water quality changing in Lingdingyang Estuary (Fig. 2 - 5, Table 11). First, the oil, organic chlorine pesticide and mental were main pollutants at the end of 1970s and the beginning of 1980s. Second, organic pollution became main problem, and the mental pollution was not effectively managed in the end of 1980s. Third, at the early of 1990s, mental pollution was effectively controlled, and organic pollution was kept within limits, but the issue of nourishment was appearing in, and N and P became main pollutants. Last, organic pollution, such as COD, was managed better than before, the index of it reached the 2nd standard. But the contents of N and P are going up, and the ecology problems brought out owing to nourishment. For example, ION content was beyond of the 4th criterion, P exceeded the grade 1, they were most principal pollutants yet.

Because the new standard of marine is stricter than old one, especially mental, the contents of mental exceeded standard at large before the 1990s, but were notably reduced and accorded with the standard in 1993 and 1996 (Table 10). It shows that our government attaches importance to manage mental pollution at all times and gets good effect.

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Table 10 Monitoring results of 1996

		Flood tide			Ebb tide			Average
		Range	Average	Rate	Range	Average	Rate	
Salinity	surface	0.007 - 12.248	5.195	0	0.008 - 13.675	4.752	0	9.27
	bottom	0.008 - 29.245	12.387		0.008 - 32.908	14.744		
pH	surface	7.12 - 8.16	7.77	8.6	6.70 - 8.14	7.71	20	7.77
	bottom	7.13 - 8.13	7.83		6.82 - 8.09	7.78		
DO(mg/L)	surface	4.10 - 6.77	6.21	0	4.79 - 9.36	6.50	2.9	5.99
	bottom	4.31 - 6.94	5.61		3.75 - 6.94	5.62		
SS(mg/L)	surface	2.4 - 288.8	103.4	0	1.6 - 1891.7	303.2	0	197.9
	bottom	14.2 - 491.67	153.54		12.6 - 981.67	231.23		
COD(mg/L)	surface	0.95 - 2.85	1.63	5.7	0.94 - 4.18	2.10	5.7	1.82
	bottom	0.48 - 4.30	1.71		0.32 - 4.43	1.85		
Phosphate(mg/L)	surface	3.3 - 18.7	12.1	0	2.1 - 21.3	10.2	0	10.2
	bottom	2.6 - 22.4	8.6		2.6 - 20.6	9.8		
Labile-P(mg/L)	surface	0.016 - 0.026	0.021	0	0.019 - 0.033	0.026	0	0.023
	bottom	0.007 - 0.032	0.021		0.005 - 0.040	0.025		
TP(mg/L)	surface	0.032 - 0.068	0.048	0	0.036 - 0.080	0.050	0	0.057
	bottom	0.052 - 0.084	0.067		0.044 - 0.088	0.061		
ION(mg/L)	surface	0.112 - 1.103	0.561	77.1	0.108 - 1.030	0.533	85.7	0.506
	bottom	0.092 - 1.255	0.527		0.083 - 0.969	0.402		
NO_3-N(mg/L)	surface	0.084 - 1.082	0.520	0	0.075 - 1.005	0.506	0	0.454
	bottom	0.077 - 1.140	0.409		0.055 - 0.945	0.379		
NO_2-N(mg/L)	surface	0.008 - 0.085	0.027	0	0.002 - 0.013	0.022	0	0.026
	bottom	0.008 - 0.089	0.026		0.001 - 0.147	0.030		
NH_3-N(mg/L)	surface	# - 0.260	0.098	0	# - 0.518	0.074	0	0.306
	bottom	# - 0.254	0.082		# - 0.167	0.052		
TN(mg/L)	surface	0.389 - 0.570	0.499	0	0.437 - 0.640	0.524	0	0.544
	bottom	0.486 - 0.597	0.539		0.542 - 0.678	0.615		
Oil(mg/L)	surface	# - 0.104	0.045	5.7	# - 0.078	0.038	0	0.039
	bottom	# - 0.085	0.042		# - 0.080	0.033		
Cl^-(mg/L)	surface	0.451 - 9.346	1.864	0	0.317 - 0.960	0.577	0	0.928
	bottom	0.434 - 1.135	0.659		0.451 - 0.951	0.611		
Anionic	surface	0.070 - 0.211	0.109	0	0.054 - 0.130	0.083	0	0.097
detergent	bottom	0.054 - 0.167	0.111		0.054 - 0.113	0.085		
Hg(μg/L)	surface	# - 0.016	0.008	0	# - 0.072	0.017	0	0.013
	bottom	# - 0.047	0.013		# - 0.027	0.012		
Cu(μg/L)	surface	# - #	0.5	0	# - 1.8	0.9	0	0.8
	bottom	# - 1.4	0.7		# - 2.3	1.2		
Pb(μg/L)	surface	# - 3.0	0.7	0	# - 2.1	0.7	0	0.7
	bottom	# - 2.7	0.7		# - 1.6	0.6		
Zn(μg/L)	surface	# - 10.1	3.1	0	# - 10.1	3.4	0	4.0
	bottom	2.4 - 15.8	4.6		1.5 - 9.0	4.8		
Cd(μg/L)	surface	# - #	0.2	0	# - #	0.2	0	0.2
	bottom	# -	0.2		# - #	0.2		

Note: # express not check out, its average is half of check out limit.

Table 11 Comparison of monitoring results from 1977 to 1996

	1977	1978	1979	1980	1981	1988	1993	1996	Old 1st standard	Old 2nd standard	New 1st standard	New 2nd standard
DO(mg/L)							5.96	5.99	5	4	6	5
COD(mg/L)	0.76	0.65	1.07	0.65	0.87	2.53	2.10	1.82	3	4	2	3
Oil(mg/L)	0.042	0.059	0.036	0.103	0.121	0.032	0.078	0.039	0.05	0.10	0.05	0.05
Labile-P(mg/L)								0.023			0.015	0.03
IOP(mg/L)						0.031	0.021		0.015	0.03		
ION(mg/L)						0.315	0.824	0.506	0.1	0.2	0.2	0.3
Hg(μg/L)	0.022	0.023	0.036	0.018	0.024		0.11	0.013	0.5	1.0	0.05	0.2
Cu(μg/L)	3.2	5.3	4.0	14.1	5.0	5.1	0.38	0.8	10	100	5	10
Pb(μg/L)	43	38.2	8.0	7.0	9.0	11.4	0.86	0.7	50	100	1	5
Zn(μg/L)	16.1		14.6	41.6	48	39.7		4.0	100	1000	20	50
Cd(μg/L)	1.4		0.3	0.1	1.0	0.92	0.37	0.2	5	10	1	5