ECONOMIC DEVELOPMENT OF COASTAL AREA AND ESTUARINE WATER QUALITY MANAGEMENT IN CHINA

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An estuary is a semi--enclosed coastal body of water which has a free connection with the open sea. The estusrine and coastal water system can provide men with a capacity of waste assimilation, recreation ground and aquatic product resource, but human activities and economic development bring about pollution and degradation of estuarine and coastal water quality at the same time. So coordination of conflict between cost-effective waste disposal and marine environment protection is a serious task. Water quality management system should consist of three parts which are pollution occurence system, pollution control system and water environment system received effluent. The tasks of water quality management above mentioned three parts are the reduction of pollutants and waste water produced, the decrease of pollutnats and waste water discharge and the monitoring of water quality and use of capacity of water environment to assimilate waste respectively.

Economic Development of Coastal Area in China and Environmental Problems

Since 1980's, many specific economic districts and the economic and technological development regions were established in Chinese coast zone where economy has emerged and urbanization was picked up speed. The once desolate small towns have been become modernized cities. With the economic strength enhancement and the reform and opening in depth, the environmental protection facilities are improved. In some places, despite production has doubled and redoubled, the environmental quality is in its original good state. In contrast, the environment especially the estuarine water quality has been destroyed in varying degrees in many coastal zones because of shortage of reasonal pollution mitigation and environment management plan as well as control measures. Even in order to attract more foreign investment interprises, some ones have the behavior of "**a hungry person is not choosy his food**" and introduced serious contamination industries, with the result that estuarine and coastal sea were polluted by oil, organic pollutants, nutriets and heavy metals, and has caused eutrophication and red tide problems such as the Bohai Bay, Huangzhou Bay and Shenzhen Bay. There are seven large area red tides occured in 1989, and induced lose of 10 thousands -20 thousands ton aquatic products, or the lose of several hundreds million Chinese yuan. In 1990, the red tide area of sea near Huanghua City was 100Km^2 and caused the economic lose of 90 million Chinese yuan. The entering pollutants are mainly from land in which Bo sea, Huang sea, East China sea and South China sea receive 16%, 12%, 50% and 21% respectively.

Water Quality Model of Minjiang Estuary

The River Minjiang is the largest one of Fujian province at southeast China and has a catchment area of 60992 Km^2 which has a good water quality and low sand contnent at the the present, and has table 1. water-environmental capacity for BOD_5 and NH_3-N (t/d)

segment name	weighted volume	decay constants BOD₅	decay constants NH₃-N	BOD₅ at 385m³/s	BOD₅ at 715m³/s	NH₃-N at 385m³/s	NH₃-N at 715m³/s
Luoxinta -Honshan	0.12	0.250	0.172	7.31	13.6	0.92	1.72
Hongshan -Minan	0.14	0.250	0.172	8.53	15.8	1.08	2.00
Minan -Tingjiang	0.06	0.250	0.172	3.66	6.79	0.46	0.86
Tingiang -Chuanshi	0.63	0.200	0.172	37.1	69.0	0.39	0.72
Tingjiang -Fuqi	0.05	0.200	0.172	2.95	5.50	0.39	0.72
total	1.0			59.6	111	1.70	14.3

Pollution Control of Minjiang Estuary

To maintain the water quality use function of Minjiang estuary and to reserve enough water-environmental capacity for economic development in downsteram areas of Mawei, the waste waters from Fuzhou, Mawei and Guantou must be treated to meet the water quality standards required. The treatment capacity and efficiency of waste water treatment plants and their allowable discharge of BOD_5 are shown in table 2. In order to guarantee normal operation of waste water treatment plants above mentioned, the heavy metals and toxical organic substances must be pretreated before the waste water enter to the treatment plants.

table 2. waste water treatment plants

location of waste water plant	teratment capacity (t/d)	BOD_5 removal efficiency (%)	allowable discharge of BOD_5 (t/d)
Fuzhou	500000	70	15
Mawei	50000	80	1.5
Guantou	30000	80	2.3

In addition to waste water treatment plants, the reasonal industrial structure and distribution are also important for water environmental protection.

an average volume rate of $1750m^3/s$ and annual average runoff of $5.5\times10^{11}m^3$ at Mawei section. The River Minjiang performs function of water suplly and has very large economic development potential. The Mawei Economic and Technological Development Distict is on the right bank of downstream of Minjiang river .

The flushing time of a pollutant, as determined by the method of fraction of freshwater , the formulation as follows

$$T=\sum_{i=1}^{n}\frac{f_iV_i}{R_i} \qquad (1)$$

where T is flushing time, d; f_i is the fraction of freshwater in the ith segment; Vi is the total volume of water in the ith segment, m^3; Ri is trhe freshwater discharge in the ith segment, m^3/d. Using eq. 1, the calculated flushing time of conservative pollutants during dry and raining periods are 12 and 7 days respectively from Mawei to river mouth.

In order to evaluate water environment capacity for pollutants, a two-dimensional mathematical model was made. The equation is

$$Dx\frac{\partial^2(hc)}{\partial x^2}+Dy\frac{\partial^2(hc)}{\partial y^2}-Ux\frac{\partial(hc)}{\partial x}-Uy\frac{\partial(hc)}{\partial y}+S=0 \qquad (2)$$

where c is concentration of pollutants, mg/L; Dx and Dy are longitudinal and lateral dispersion coefficients, m^2/s; Ux is tidal averaged velocity in the x direction, m/s; Uy is tidal averaged velocity in the y direction, m/s; h is the mean depth of water, m; S is sinks and sources.

Rhodamine-B tracer was used to determine the dispersion coefficients Dx and Dy . The results show that Dx value under flood condition is greater than under ebb condition and Dy value under flood is smaller than ebb. The water-environmental capacity is defined as the capacity of a given water body to contain the accumulated pollutants without sacrificing the water quality. The calculation formula of water-environmental capacity as follows

$$Wc=\sum_{i=1}^{n}Wci$$

$$=\sum_{i=1}^{n}WiQi\ (Csi-Cbi)\ (2-EXP\ (-Kit)\ )\times0.0864 \qquad (3)$$

where Wc is total capacity of all segments, t/d; Wci is the capacity in the ith segment, t/d; Wi is the weighted volume of water in the ith segment; Csi is required water standard of any given pollutant in the ith segment, mg/L; Cbi is background value of pollutant in the ith segment, mg/L; Ki is the decay rate constant of pollutant in the ith segment, d^{-1}; Q is the volume flow rate of freshwater in the estuary, m^3/s. The eq.3 was used to calculate the water-environmental capacity of BOD_5 and NH_3-N at freshwater flows of 385 and $715m^3/s$ table 1) .