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Perennial Trends of Wastewater Discharge and Pollutant Content in Rivers of Shanghai

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***Abstract*—Water Environment in Shanghai got more and more attentions. The hotspots are wastewater discharge and pollutant content in Changjiang and Huangpu rivers. From 1981 to 2009, the city wastewater discharge was fluctuated between $18*10^8$ ton and $24*10^8$ ton. Inside, the gross of industrial wastewater was trendily decreasing from more than $13*10^8$ ton at 1980s to about $7*10^8$ ton recently years. The percent of industrial wastewater was decreasing continuously from 76.88% at 1981 to 28.42% at 2009. The gross of living wastewater was increasing trendily, it related with increasing of city population. In the same period, the living wastewater per year for per person was increasing from about 37 ton at the beginning of 1980s to 80 ton at recent year, about 1.2 times increasing in past 30 years. The month flux of chemical pollutant discharged by Changjiang River was between $25.9*10^4$ ton to $209.6*10^4$ ton in recently years. The average pollutant gross carried by Changjiang River in year, was about $593.45*10^4$ ton among 2002 to 2009; about 83.68% was COD. Other pollutants were nutrients, oil, heavy metal and arsenic, the variability was larger with year. The month flux of pollutant carried by Huangpu River was $2.56*10^4$ ton, more than 63% was COD averagely. The pollutant gross had an increasing trend year by year. Generally, the percent of pollutant from Huangpu River was about 3.6 to 4.4% compared with that in Changjiang River.**

Keywords: Shanghai; Water Environment; Water Pollution; Changjiang Estuary; Huangpu River; Shanghai Sea

I. INTRODUCTION

Shanghai, neighbors Changjiang River and faces to East China Sea. Huangpu River, the mother river, flows across the city. There is a rich river net, the density of river net is about 3.93 km/km^2, covered more than 10% area of the city. The water environment impacts the city development. In past 30 years, with population increasing, city area is enlarging, the more pressures put on water environment, and the situation of water environment gets more attention from publics and government. The hotspot is wastewater discharge and pollutants carried in rivers. Here, it is analyzed and discussed that the perennial trend of city wastewater discharge and pollutants in rivers of Changjiang and Huangpu. The data are extracted from Environmental Bulletins[1] and report[2] , Water Resource Bulletins[3], Oceanic Environmental Bulletins[4, 5] and briefings[6] of administrations in each year.

II. THE CITY WASTEWATER DISCHARGE DURING 1981-2009

The statistics from data of the annual Municipal Bulletins, show that gross city wastewater was around $17.75*10^8$ ton to $24.20*10^8$ ton during 1981-2009, with minimum at 1982 and maximum at 1996, the discharge was increasing from 2003 (figure 1). Inside, the load of industrial wastewater was more than $13*10^8$ ton before 1992, then decreasing to $6.49*10^8$ ton, less than 50%, at 2002. In these years, it was increasing ratherish. The amount of living wastewater, generally, was increasing for last 30 years. There are several stages, 1981-1990, 1995-2001 were gently increasing; 1990-1992, 2001-2003 were little decreasing; 1992-1995 rapidly increasing and 2004-2009 continually increasing.

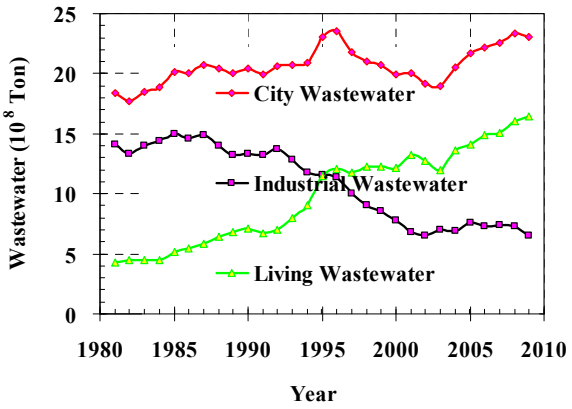

Fig. 1 The Shanghai city wastewater discharge during 1981-2009

The increasing trend of living wastewater discharge is related with population increasing. Comparing with the population data[7], it can be found that before 2000, the increasing speed of population was less than the increasing of living wastewater; from 2003, the both increasing ratios were closely (figure 2). The computing show, that the living wastewater discharge for per person in per year, is increasing, from 36.5-38 ton at the beginning of 1980s to 80-85 ton around these years, it is about 219 liter per day now, about 1.2 times increasing for per person in last 30 years. The increasing ratios got to 25% during 1993-1995 (figure 3); it

implies some deficiency at administration. The amount of living wastewater per person fluctuated little in past 5 years.

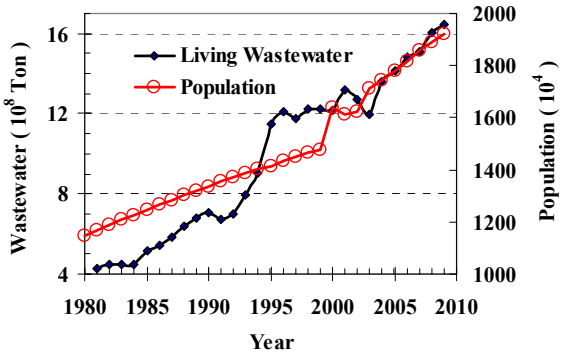

Fig. 2 The relationship between living wastewater discharge and population at Shanghai in 1981-2009

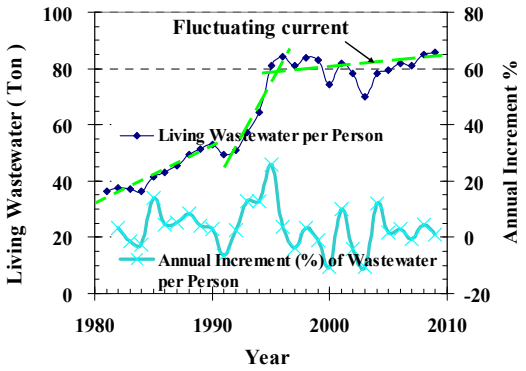

Fig. 3 The change of average living wastewater per person-year during 1981-2009

III. THE SEASONAL CHANGE OF POLLUTANT FLUXES IN CHANGJIANG AND HUANGPU ESTUARIES

Using Feb, May, Aug, Nov as the representation of four seasons, extracting the data of pollutant flux in Changjiang and Huangpu Estuaries from State and Municipal reports in different month, it can be got, that pollutant flux at Changjiang estuary was less at Feb around $25.94*10^4$ ton to $55.54*10^4$ ton, the flux got more between $56.60*10^4$ ton to $209.60*10^4$ ton at Aug. The variability is minimum in Nov and maximum in Aug for different year, (figure 4).

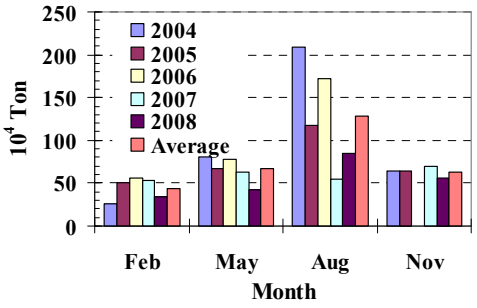

Fig. 4 The seasonal change of main pollutant flux in Changjiang Estuary

The pollutant flux at Huangpu estuary for 2005-2008, averaging in years, was less at May about $1.75*10^4$ ton, and more at Feb around $3.64*10^4$ ton; the maximum flux is near $6.74*10^4$ ton, and minimum about $0.83*10^4$ ton. The variability is most at Feb and least in Aug, (Figure 5).

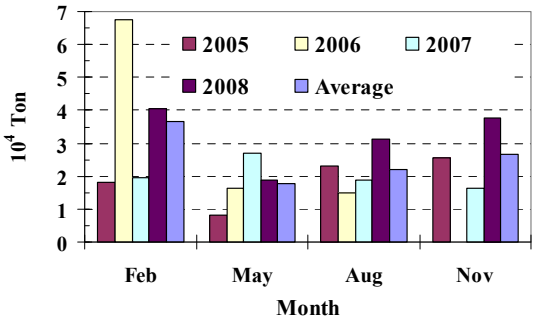

Fig. 5 The seasonal change of main pollutant flux in Huangpu Estuary

The percent of pollutant flux of Huangpu River compared with Changjiang River was 7.84% in Feb, 3.00% in May, 2.49% in Aug and 4.38% in Nov, averaging for recently years, with maximum 12.1% and minimum 0.86%. Monthly average was 4.43%. The variability was maximum at Aug about 4.06 times and minimum at May near 2.01 times, (figure 6).

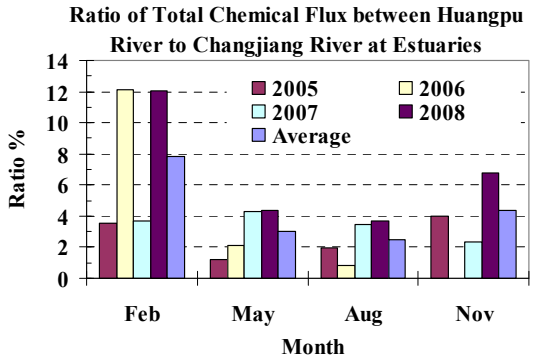

Fig. 6 The Ratio of Pollutants between Huangpu River to Changjiang River

Except suspended material, the main part of chemic pollutant in Changjiang River was chemical oxygen demand (COD). Averagely, the COD flux is less in Feb near $27.05*10^4$ ton, and most at Aug around $83.05*10^4$ ton. The variability was largest in Aug and least in Feb (see: figure 7). The percent of COD in gross of chemical pollutant was 63.55% in month averagely, with largest in Nov and least in Feb. The different between years can be >20%.

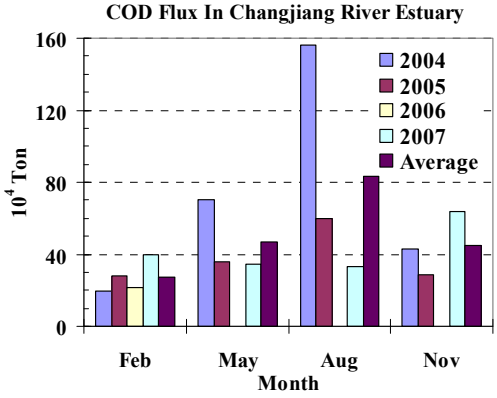

Fig. 7 The seasonal change of COD flux in Changjiang Estuary

The COD flux of Huangpu river was $1.43*10^4$ ton with month averagely, about 63.49% in gross of chemical pollutants. The flux is larger in Feb around $1.65*10^4$ ton and least at May about $1.21*10^4$ ton, (figure 8); the COD percent in gross of chemical pollutants was higher in Nov near 71.68% and lowest at Feb about 59.21%.

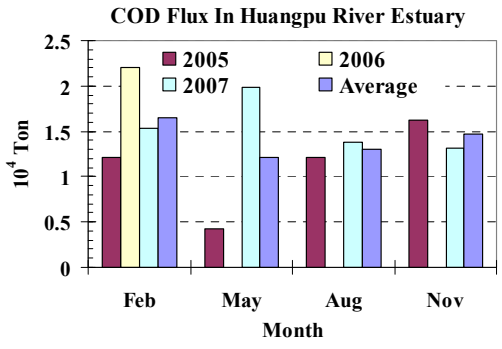

Fig. 8 The seasonal change of COD flux in Huangpu Estuary

IV. The Perennial Change of Pollutant Flux in Changjiang and Huangpu Estuaries

The statistic shows, that the gross discharges of chemical pollutant from Changjiang River was least at 2003 about $292.94*10^4$ ton, and largest at 2004 near $791.43*10^4$ ton among 2002 and 2009, (figure 9). Annual average was $593.45*10^4$ ton. The 56.95%~98.6% was COD. Other pollutants were nutrients, oil, heavy metal and arsenic, with a larger variability yearly, (figure 10).

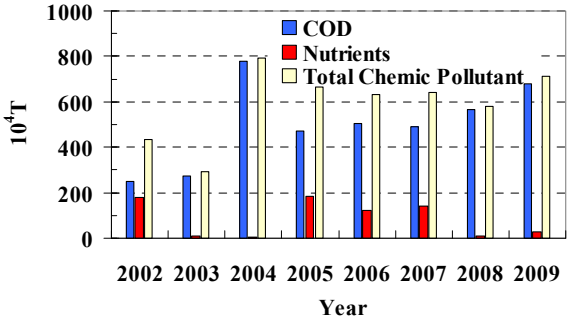

Fig. 9 Annual change of gross pollutant, COD and Nutrients at Changjiang Estuary

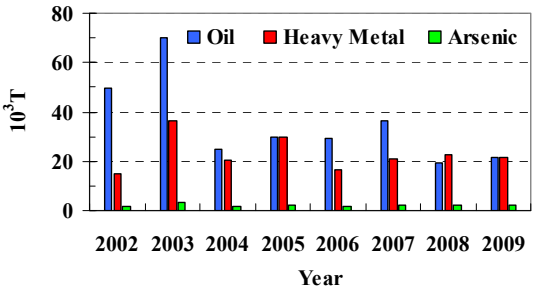

Fig. 10 Annual concentration change of oil, heavy metal and arsenic at Changjiang Estuary

The gross of chemical pollutant from Huangpu River was around 108820 ton to 470418 ton, increasing yearly, 87.94% was COD, (figure 11). Other pollutants were nutrients, oil, heavy metal and arsenic, (figure 12).

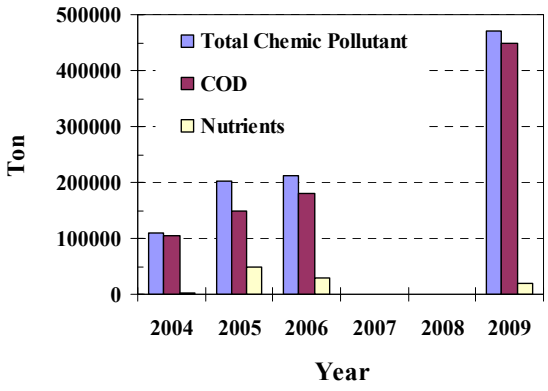

Fig. 11 Annual change of gross pollutant, COD and Nutrients at Huangpu Estuary

Averaging yearly, the percent of pollutants carried by Huangpu River comparing with Changjiang River, was 3.6%, fluctuated from 1.37% to 6.63%; the percents of oil and arsenic were higher, (figure 13).

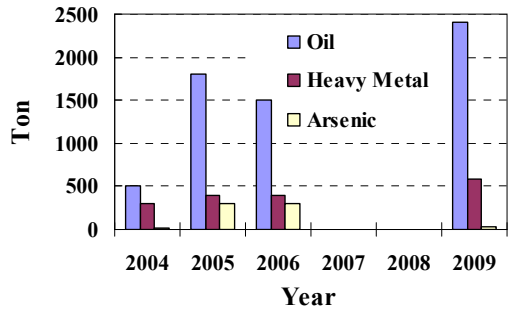

Fig. 12 Annual concentration change of oil, heavy metal and arsenic at Huangpu Estuary

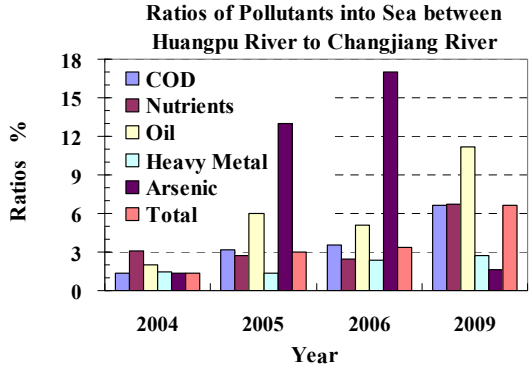

Fig. 13 The percent of pollutants carried by Huangpu River compared with Changjiang River

V. CONCLUSION

For past 30 years, the changing trend of the city wastewater discharge in Shanghai, shows three stages, it was increasing from 1981-1996, decreasing between 1996-2003, then increasing again from 2004-2009. Now, the gross of city wastewater discharge is about $23*10^8$ ton. Inside, the gross of industrial wastewater was trendily decreasing from more than $13*10^8$ ton at 1980s to about $7*10^8$ ton recently years. The percent of industrial wastewater was decreasing continuously from 76.88% at 1981 to 28.42% at 2009. The gross of living wastewater was increasing trendily, it related with increasing of city population. The increase speed of living wastewater gross was rapider than city population increasing speed before 1996, the two increasing speeds was closely from 2002 to 2009. In the same period, the living wastewater per year for per person was increasing from 37 ton at the beginning of 1980s to 80 ton at recent years, about 1.2 times increasing in past 30 years.

The month flux of chemical pollutant discharged by Changjiang River was between $25.9*10^4$ ton ~ $209.6*10^4$ ton in recently years; the flux was lower in winter and higher in summer, the different was 2.3 to 8.1 times. The average value of pollutant gross carried by Changjiang River per year, was about $593.45*10^4$ ton among 2002 to 2009. About 83.68% was COD. Other pollutants were nutrients, oil, heavy metal and arsenic, the variability was larger with year.

The month flux of pollutant carried by Huangpu river was $2.56*10^4$ ton, 63% was COD averagely. There was an increasing trend, that pollutant gross was discharged by Huangpu River, year by year. Generally, the percent of pollutant from Huangpu River was about 3.6% to 4.4% compared with that in Changjiang River.

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