

# Study of the water quality in Liaohe Park based on the model of GAM

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**Abstract:** This paper assesses the quality of Daliao river through Liaohe Park based on the model of GAM for water quality analysis and the monitoring data from 2006 to 2011. The results showed that the value of pH per year tended to the average; the DO in 2011 was much higher than that in other years, and the DO in 2006 was lower than the standard value; the quality risk in six sections was still higher than the standard value in 2007, which was caused by the high concentrations of COD. However, the value of ammonia nitrogen changes was only 40% related to DO and COD.

**Keywords:** Liaohe Park, water quality monitoring, evaluation

Liaohe Park is at the estuary of the Daliaohe River which is Yingkou's mother river. The city landscape in Yingkou is an unique advantage for Liaohe. By the end of 2005, length of Liaohe Park is more than 2 600 meters, with a total area of 138000 square meters, which consists of ecological landscape areas, city squares, leisure landscape areas, citizen sports squares and so on, which contribute to ecological benefits.

However, frequent human activities (agricultural and industrial sewage discharge) caused water pollution, which affects inshore sea environment of estuary of Liaohe and disturbs wetland landscape pattern's dynamics<sup>[1]</sup>. In view of this, some scholars<sup>[2]</sup> introduced the space satellite remote sensing combination of the ground monitoring technology to realize the water pollution accident emergency monitor; 3S technique based on the Daliaohe River water quality automatic online real-time monitoring and pollution accident emergency treatment system. In addition, the computer, 3S and the water environment comprehensive management technology constantly will be improved<sup>[3]</sup> to provide the theory and technology support to establish the monitoring system of the ocean environmental pollution, and to perfect the whole coastal Marine water quality protection policy.

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## 1 The sources of data

The data in this paper from the system of water quality automatic real-time monitoring for surface water in six years (2006 - 2011) which including Ph, DO, COD, ammonia nitrogen. Liaohe Park is the estuary of Daliaohe River where latitude is  $40^{\circ}40'50.87''$  and longitude is  $122^{\circ}14'39.66''$ ).

## 2 The figures of stance



Fig. 1 Upper estuarine zone of the Daliaohe River



Fig. 2 Liaohe Park

### 3 Infusions and analyses

#### 3.1 Index for water

Collecting and summarizing the data of 2006 - 2011. (Tab. 1)

	pH	DO	COD	NH <sub>3</sub>
2011	7.61±0.209	6.93±1.788	9.45±0.499	2.58±1.552
2010	7.21±0.250	4.39±1.103	9.43±0.171	4.74±2.921
2009	6.93±0.110	4.34±2.093	9.41±1.519	4.48±2.628
2008	7.15±0.094	2.53±1.094	13.67±3.447	3.80±3.949
2007	7.18±0.090	3.29±2.435	11.02±3.862	8.09±5.590
2006	7.30±0.173	1.82±1.101	9.28±2.395	3.98±3.023
Means±SEM	7.23±0.223	3.88±1.799	10.38±1.741	4.61±1.861

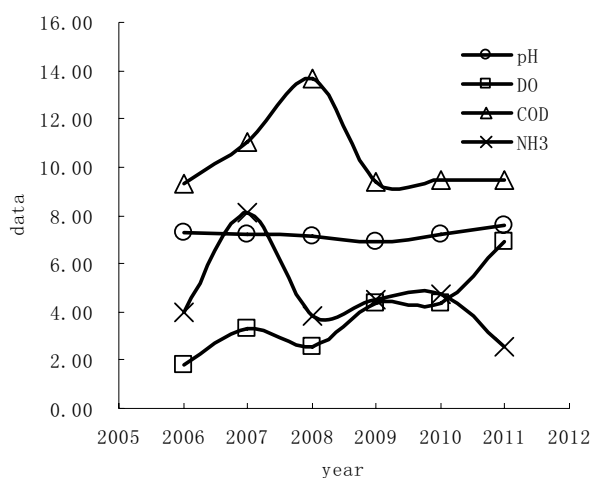


Fig. 3 Change of indices by years

Fig. 3 can be seen flattened that the change of pH from 2006 to 2011, the average value was 7.23; the value of DO presented wavy lines and the value of DO in 2011 was significantly higher than that in other years, and the minimum value of DO was 1.82 mg/L in 2006; the value of COD present parabolic lines, and the value of 13.67 mg/L in 2007 was significantly higher than that in the other years; the value of NH<sub>3</sub> in 2007 was the highest, about 8.09 mg/L, but it generally presented declining trend year by year.

### 3.2 Statistical analysis

Because the data is very less, regression analysis was made based on the model of GAM:  $y$ -NH<sub>3</sub>;  $x_1$ -pH;  $x_2$ -DO;  $x_3$ -COD.

Analysis results are as follows:

Family: gaussian

Link function: identity

Formula:  $y \sim s(x_1) + s(x_2) + s(x_3)$

**Tab. 2 Operation results**

Parametric coefficients:				
	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	4.585 2	0.287 9	15.93	<2e-16 ***

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**Tab. 3 Approximate significance of smooth terms**

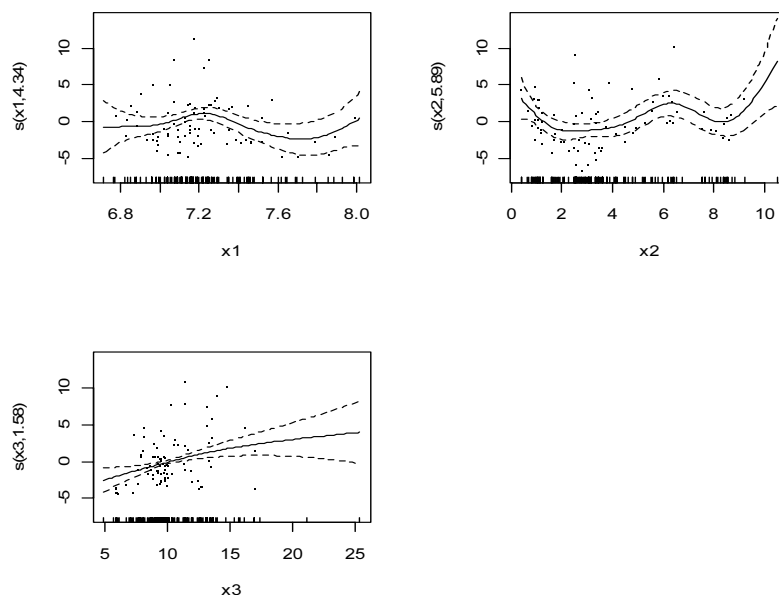
	edf	Ref.df	F	p-value
s(x1)	4.339	5.336	1.921	0.091 473 .
s(x2)	5.886	7.052	3.913	0.000 707 ***
s(x3)	1.575	1.958	7.177	0.001 252 **

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**Tab. 4 Results**

R-sq.(adj)	0.303
Deviance explained	36.8%
GCV score	11.789
Scale est.	10.61
n	128

The partial correlation relationship of Ammonia nitrogen and three other variables is as follows:



**Fig. 4 Relationship of NH<sub>3</sub> and pH, DO, COD**

Judging from the outcome, the relationship of ammonia nitrogen and pH is not significantly close, and DO and COD is significantly correlated; the concentration of ammonia nitrogen and COD are related, and for DO, they show complicated nonlinear relation, showing W shape. pH, COD and DO can explain 40% for ammonia nitrogen changes.

## 4 Conclusions

(1) The Daliaohe river system in China has been seriously affected by long-term intensive industrial, urban and agricultural activities<sup>[4]</sup>. The objective of this study was to evaluate the water quality for Liaohe Park. From the results, the value of COD was 13.67 mg/L in 2007, where was significantly higher than that in the other years. Causing the reasons of this phenomenon, it may be viscosity medium in sediments<sup>[5]</sup> which could be conducive to the utilization by bacteria, thus increasing the content of organic matter. A recent report by CHEN Shuang<sup>[6, 7]</sup> confirmed this results.

(2) The relationship of ammonia nitrogen and DO show complicated nonlinear relation, because temperature, salinity, animal activity nutrient and organic pollutants could impact the change of DO, especially causing serious pollution in the anthrosphere<sup>[8]</sup>.

(3) A combination of both these factors remains unknown. Thus many aspects will be researched in future, such as data acquisition, model and the fixed parameters, as well as analysis on the bioaccumulation of toxic substances to the health of people and so on.

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## 基于 GAM 模型对辽河公园水质的研究

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**摘要:** 基于 GAM 模型对2006 ~ 2011年辽河公园水质监测数据进行分析, 旨在对大辽河水质进行评价。结果显示, 每年pH值趋于一致; 2011年溶解氧明显高于其它年份, 且2006年溶解氧达到最低值。就6年的监测数据进行风险评估发现, 2007年COD浓度较高且高于平均值; 然而, 溶解氧和COD与氨态氮的变化只有40%的相关。

**关键词:** 辽河公园; 水质监测; 评价