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Evaluation and Study of Danao Flood Canal and BaiShou Bay Sediment in Huizhou under COVID -19 Epidemic

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Abstract:
The COVID-19 epidemic has had a huge impact on human society, providing an opportunity for human beings to reflect on environmental governance. The sediment samples were collected from the Diversion Channel and Baishou Bay in Huizhou to analyze the element speciation distribution and pollution status. By graphite furnace atomic absorption spectrometry, atomic fluorescence spectrophotometry, flame atomic absorption Spectrophotometric methods to determine the content of the bottom sediments. The single factor index method, the Nemero comprehensive index method, the pollution load index method and the coefficient of variation analysis method were used to analyze. This study on the river bottom sediments of Huizhou is significant environmental effects of harmful elements.

***Keywords**: Single factor index method, Nemerow synthetic index method, Pollution load index method, Variation coefficient method.*

I. INTRODUCTION

The COVID-19 epidemic has had a huge impact on human society, providing an opportunity for human beings to reflect on environmental governance, and making more people realize the need to take concrete actions and make more changes in protecting the earth's ecology. Water is one of the natural resources we live by, also an important component of the ecological environment, which is very sensitive to environmental changes. Due to the intervention of human activities, more and more pollutants have entered the water environment, bringing various problems for our living environment.

With the rapid social and economic development, we raise higher requirements in all aspects of life. Water is an indispensable material for our lives. However, with the fast modern industrial development, increasing sewage is discharged into the water environment, polluting many rivers and destroying aquatic ecosystems. Heavy metal pollution is latent, toxic, difficult to remove, and can be enriched and absorbed in the food chain, so rivers as important water sources in all aspects indirectly or directly affects people’s health, more or less threatening other organisms [1,2].

Pollution status of sediments in the water body is an important factor to comprehensively measure the quality of water environment. Therefore, research on heavy metal pollution in rivers has always been a hot spot at home and abroad. The problem of heavy metal pollution in rivers has always received much attention in China, and the pollution rate of heavy metals is as high as 81%. For example, in the Yangtze River Basin of China, there is serious pollution caused by zinc, lead, cadmium, copper, chromium elements, while sulfophilic elements such as chromium, lead, mercury and copper have great potential activities,

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which can easily react with many substances in the water environment. Studies have shown that sediments in the main stream of Yangtze River have high levels of heavy metals, with its coastal waters polluted to varying degrees, and cumulative pollution rate of heavy metals has reached 65% [3,4].

The epidemic highlights the importance of scientific and technological development. Chinese scholars and researchers have conducted extensive and thorough research on heavy metal pollution in major river systems in China. Studies have shown that heavy metal content in suspended matter has relation to characteristics of the suspended matter. Suspended matter in the dry season is mainly clay minerals with strong adsorption capacity, so the heavy metal content is relatively high. Suspended matter in the wet season is mainly felsic clastic minerals, so the heavy metal content is relatively low [5,6].

II. MATERIALS AND METHODS

2.1 Regional Overview

Huizhou City, a well-known city in Guangdong Province, is located at the northeastern end of the Pearl River Delta. Formerly known as Xunzhou and Zhenzhou, it has a founding history of more than 1,400 years, serving as the political, economic and cultural transportation center of the Dongjiang river basin since ancient times [7].

Danao River flood diversion channel was built in 1975 to relieve the pressure of flood discharge in Shenzhen and Huiyang in the upper reaches of the Xizhi River and Danshui River. The entire river channel crosses the central urban area of Daya Bay [8].

2.2 Monitoring Point Layout

According to water body distribution features and surrounding environment characteristics, a total of 4 monitoring points were set up. The specific positions of the monitoring points are shown in Table I and Fig 1.

Table I. Position of sediment monitoring points

No.	Section location	Water body
#1	Danao flood diversion channel at 100 meters upstream of the outlet of Huiyang District Wastewater Treatment Plant	Danao flood diversion channel
#2	20 meters downstream of sewage outlet of the East Gate Bridge project	Danao flood diversion channel
#3	At the confluence of Xiangshui River and Danao flood diversion channel in Daya Bay	Danao River
#4	Baishou Bay Marine Ecosystem Reserve	Daya Bay waters

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Fig 1: Distribution map of sediment monitoring points

2.3 Analysis Standards and Methods

Sampling and analysis in this study were carried out in accordance with “Technical Specifications for Soil Environmental Monitoring” (HJ/T 166-2004). Copper, lead, cadmium, chromium, nickel were detected by atomic absorption spectrophotometer, while mercury and arsenic were detected by atomic fluorescence spectrophotometer [9], specifically as in Table II:

Table II. List of inspection criteria (methods) and instruments used

Inspection item	Inspection criteria (methods)	Instruments used		Method detection limit
		Instrument name	Number	
pH value	NY/T 1121.2-2006	pH meter	YQ-072	——
Mercury	GB/T 22105.1-2008	atomic fluorescence	YQ-002	0.002mg/kg
Copper	NY/T 1613-2008	atomic absorption	YQ-001	2.0mg/kg
Lead	NY/T 1613-2008	atomic absorption	YQ-001	5.0mg/kg
Cadmium	NY/T 1613-2008	atomic absorption	YQ-001	0.01mg/kg
Chromium	NY/T 1613-2008	atomic absorption	YQ-001	5.0mg/kg
Nickel	NY/T 1613-2008	atomic absorption	YQ-001	2.0mg/kg
Arsenic	GB/T 22105.2-2008	atomic fluorescence	YQ-002	0.01mg/kg

III. EVALUATION CRITERIA AND EVALUATION METHODS

3.1 Evaluation Criteria

Since China has not promulgated relevant river sediment environmental quality standards, the current assessment and research on river bottom sediments was carried out with reference to the second level standard of "Soil Environmental Quality Standards" (GB15618-1995), while that of marine sediments was performed with reference to second level standard of "Marine Sediment Quality" (GB18668-2002) [10,11]. The soil background value refers to soil background value of Guangdong Province.

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3.2 Evaluation Methods

In this study, single factor index method, Nemerow synthetic pollution index method, pollution load index method and variation coefficient analysis method were adopted for spatial analysis on the distribution and pollution degree of sediments in Huizhou Danao flood diversion channel and Baishou Bay.

3.2.1 Single factor index method

Single factor index method is the most commonly used evaluation method in China, which is to determine the comprehensive water quality category of the water body based on the category of single water quality index for the poorest water quality. That is, it determines water quality category by comparing the water body monitoring results with classification standards of the project. The category with the poorest water quality was selected as the water quality category of the water body [12]. The calculation formula of the method is as follows:

$$P_i = C_i / S_i \quad (1)$$

Where: P_i- environmental quality index of pollutant *i* in soil

C_i- measured concentration of pollutant *i*, $mg.kg^{-1}$

S_i—Critical value of Class II standard in soil environmental quality standards for i heavy metals (GB15618-1995) and Class II standard for marine sediment quality (GB18668-2002), $pH>7.5$, $mg.kg^{-1}$

3.2.2 Nemerow index method

Based on single factor index evaluation, Nemerow synthetic pollution index method is one of the most commonly used methods for synthetic pollution index calculation at home and abroad. This method first calculates sub-index of each factor (excess multiples), then solves the average of each sub-index, and calculates based on the maximum sub-index and the average [13]. The calculation formula of the method is as follows:

$$P_i = C_i / C_{0i} \quad (2)$$

$P_i = C_i / C_{oi}$ (i=1,2,3,…,k, k parameters; P=1,2,…,m monitoring points)

Where: P_i- Individual pollution index of pollutant *i* in soil at monitoring point *m*

C_i- Measured concentration of pollutant *i* at monitoring point *m*, $mg.kg^{-1}$

C_{oi}- Soil environmental quality standard value of *i* heavy metals, $mg.kg^{-1}$

$$P_{comprehensive} = \sqrt{\frac{\left[(\overline{P}_i)^2 + [\max(P_i)]^2\right]}{2}} \quad (3)$$

Where: $P_{comprehensive}$- Soil synthetic pollution index

$\overline{P}i$- average index of pollutants in soil

max(Pi)- Maximum pollution index of single pollutant in soil

Pollution grade is defined according to its pollution index, as shown in Table III:

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Table III. Nemerow index for soil pollution grade

Grade	Nemerow index	Pollution level
I	$P_{comprehensive} \le 0.7$	Clean (safe)
II	$0.7 < P_{comprehensive} \le 1.0$	Fairly clean (alert line)
III	$1.0 < P_{comprehensive} \le 2.0$	Light pollution
IV	$2.0 < P_{comprehensive} \le 3.0$	Moderate pollution
V	$P_{comprehensive} > 3.0$	Heavy pollution

3.2.3 Pollution load index method

Pollution load index method is an evaluation method proposed by Tomlinson et al. in the classification study on heavy metal pollution levels [14,15]. The index involves multiple heavy metal components contained in the evaluation area, which can intuitively reflect the contribution of each heavy metal to pollution, as well as heavy metal variation trend in time and space. Its application is easy [16]. The calculation formula of the method is as follows:

$$CF_i = \frac{C_i}{C_{oi}} \tag{4}$$

Where: CF_i- The highest pollution factor of element *i*

C_i-Measured value of element i, $mg.kg^{-1}$

C_{oi}- evaluation standard of element *i*, i.e. background value $mg.kg^{-1}$

(1) The pollution load index *PLI* at a certain point is:

$$PLI = \sqrt[n]{CF_1 \times CF_2 \times CF_3 \times \cdots \times CF_n} \tag{5}$$

Where: *PLI*- pollution load index at a certain point

n- number of evaluation elements

(2) Pollution load index (PLI_{zone}) of a certain zone is:

$$PLI_{zone} = \sqrt[m]{PLI_1 \times PLI_2 \times PLI_3 \times \cdots \times PLI_m} \tag{6}$$

Where: *m*-number of evaluation points (the number of sampling points)

PLI_{zone}- pollution load index of the evaluation area

Pollution load index grading is shown in Table IV

Table IV. Grade of pollution load index

PLI value	Pollution degree	Pollution level
<1	0	No pollution
1～2	I	Moderate pollution
2～3	II	Heavy pollution
≥3	III	Extremely heavy pollution

3.2.4 Variation coefficient analysis method

Variation coefficient method, also known as standard deviation method, is a statistic that weighs the degree of dispersion of each test item. It can be used in the assessment of heavy metal pollution in sediments to reflect the level of heavy metal pollution in soils. A higher variation coefficient indicates

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greater degree of dispersion in the mean per unit, suggesting greater impact of human activities, or it can also be understood as more serious pollution [17]. This paper refers to the background value of Guangdong soil [18]. The specific formula of the variation coefficient $C\ i\ V$ is:

$$C_V^i = \frac{S_n^i}{L_n^i}, i = 1,2,\ldots,m \tag{7}$$

Where: S^i_n-indicates standard deviation of a heavy metal in a river

L^i_n-indicates the average value of a heavy metal in a river

n- Number of monitoring points of a river

m- Number of heavy metals

IV. RESULTS AND ANALYSIS

4.1 Analysis of Monitoring Results

As shown in Table V and Table VI, the results show that: at #3 confluence of Xiangshui River and Danao flood diversion channel in Daya Bay, the lead content is the highest among all heavy metals in all the monitoring points, and at #1 Danao flood diversion channel at 100 meters upstream of the outlet of Huiyang District Wastewater Treatment Plant, the mercury content in is the lowest among all heavy metals in all the monitoring points.

Table V. Monitoring results of current bottom sediments in rivers within the evaluation scope (unit: mg/kg excluding pH)

Monitoring date	Monitoring item	Monitoring site				
		#1 Danao flood diversion channel at 100 meters upstream of the outlet of Huiyang District Wastewater Treatment Plant	#2 20 meters downstream of sewage outlet of the East Gate Bridge project	#3 At the confluence of Xiangshui River and Danao flood diversion channel in Daya Bay	(GB15618-1995) second level standard	
August 2015	pH value	8.73	7.56	7.57	6.5~7.5	>7.5
	Mercury	0.087	0.198	0.18	0.5	1
	Copper	12.8	38.1	45.2	100	100
	Lead	27.6	58.8	75.2	300	350
	Cadmium	0.13	0.55	0.50	0.3	0.6
	Chromium	15.5	31.3	26.4	300	350
	Nickel	26.5	58.1	56.4	50	60
	Arsenic	5.24	5.99	3.75	25	20

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Table VI. Monitoring results of current bottom sediments in seas within the evaluation scope unit: mg/kg excluding pH

Monitoring site	Monitoring item	pH value	Mercury	Copper	Lead	Cadmium	Chromium	Arsenic
#4 Baishou Bay Marine Ecosystem Reserve	Monitoring Result	8.41	0.104	53.2	18.8	0.27	15.2	1.07
	(GB 18668-2002) second level standard	—	0.5	100	130	1.5	150	65

4.2 Four Evaluation Results

4.2.1 Evaluation result of single factor index method

The formula-based calculation results are in Table VII:

The results reveal that: According to the single factor index method-based calculation and the results in Table X, the environmental quality indexes of mercury, copper, lead, cadmium, chromium, nickel, and arsenic in the monitoring points of Huizhou Danao flood diversion channel and Baishou Bay are all below 1.0 and critical values in class II standard, indicating that bottom sediments in Huizhou Danzhou flood diversion channel and Baishou Bay have not been polluted by heavy metals such as mercury, copper, lead, cadmium, chromium, nickel and arsenic.

Table VII. Pollution degree of bottom sediments in rivers within the evaluation scope

Monitoring point	P_{Hg}	Pollution degree	P_{Cu}	Pollution degree	P_{Pb}	Pollution degree	P_{Cd}	Pollution degree	P_{Cr}	Pollution degree	P_{Ni}	Pollution degree	P_{As}	Pollution degree
#1	0.087	None	0.128	None	0.079	None	0.217	None	0.044	None	0.442	None	0.262	None
#2	0.198	None	0.381	None	0.168	None	0.917	None	0.089	None	0.968	None	0.300	None
#3	0.18	None	0.452	None	0.215	None	0.833	None	0.075	None	0.94	None	0.188	None
#4	0.208	None	0.532	None	0.145	None	0.18	None	0.101	None	0.813	None	0.016	None

(Note: "None" means no artificial pollution. Pi⩽1.0: without artificial pollution, Pi> 1.0: with artificial pollution)

4.2.2 Evaluation result of Nemerow synthetic index method

The formula-based calculation results can be seen in Table VIII:

Table VIII. Degrees of heavy metal pollution in bottom sediment of Huizhou Danao flood diversion channel and Baishou Bay

Element	$\overline{P_i}$	$\max(P_i)$	$[\max(P_i)]^2$	$P_{综合}$	Pollution degree
Hg	0.1683	0.208	0.0433	0.1892	Class I (clean)
Cu	0.3733	0.532	0.2830	0.4595	Class I (clean)
Pb	0.1518	0.215	0.0462	0.1861	Class I (clean)

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Cd	0.5368	0.917	0.8409	0.7513	Class Ⅱ (fairly clean)
Cr	0.0773	0.101	0.0102	0.0899	Class I (clean)
Ni	0.7908	0.968	0.7370	0.8838	Class Ⅱ (fairly clean)
As	0.1915	0.3	0.09	0.2517	Class I (clean)

The results indicate that: According to the Nemerow index-based calculation formulas (2), (3) and results in Table VIII, the average values of mercury, copper, lead, cadmium, chromium and arsenic indexes in the sediments of Huizhou Danao flood diversion channel and Baishou Bay are below 0.7, only the average value of nickel index is above 0.7, and the maximum pollution index of cadmium and nickel is greater than 0.7. As a result, the Nemerow synthetic indexes of heavy metals mercury, copper, lead, chromium and arsenic in the bottom sediments of Huizhou Danao flood diversion channel and Baishou Bay are all below 0.7. As shown in Table VI, the bottom sediments in this area are kept clean, belonging to Class I. However, the Nemerow synthetic indexes of heavy metals cadmium and nickel are 0.7516 and 0.8838 respectively, which are above 0.7 and below 1.0. Although the soil level is class II of fairly clean, early measures should be taken to avoid the continued accumulation of cadmium and nickel.

4.2.3 Evaluation result of pollution load index method

The formula-based calculation results can be seen in Table IX.

Table IX. Degree of heavy metal pollution in the whole area

monitoring point	CF_{Hg}	CF_{Cu}	CF_{Pb}	CF_{Cd}	CF_{Cr}	CF_{Ni}	CF_{As}	PLI	Pollution degree at each point	PLI_{zone}	Pollution degree in the area
#1	0.087	0.128	0.079	0.217	0.044	0.442	0.262	0.1384	Level 0 No pollution		
#2	0.198	0.381	0.168	0.917	0.089	0.968	0.300	0.3139	Level 0 No pollution		
#3	0.18	0.452	0.215	0.833	0.075	0.94	0.188	0.2947	Level 0 No pollution	0.2154	No pollution
#4	0.208	0.532	0.145	0.18	0.101	0.813	0.016	0.1681	Level 0 No pollution		

The results indicate that: According to the pollution load index method-based calculation formula (5) and Table IX, it can be known that the pollution load indexes of the four monitoring points of Huizhou Danzhou flood diversion channel and Baishou Bay are all below 1, with corresponding pollution grades all at 0, i.e. zero pollution; formula (6) shows that the pollution load index of Huizhou Danao flood diversion channel and Baishou Bay is 0.2154, which is below 1, indicating that the bottom sediments of Huizhou Danao flood diversion channel and Baishou Bay are not polluted under synthetic impact of heavy metals.

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4.2.4 Evaluation result of variation coefficient analysis method

The formula-based calculation results can be seen in Table X.

Table X. variation coefficients of heavy metals in Huizhou Danao flood diversion channel and Baishou Bay Unit: mg/kg

Monitoring point	Hg	Cu	Pb	Cd	Cr	Ni	As
#1	0.087	12.8	27.6	0.13	15.5	26.5	5.24
#2	0.198	38.1	58.8	0.55	31.3	58.1	5.99
#3	0.18	45.2	75.2	0.50	26.4	56.4	3.75
#4	0.104	53.2	18.8	0.27	15.2	45.8	1.07
Average value	0.1423	37.325	45.1	0.3625	22.1	46.7	4.0125
Standard deviation	0.0549	17.47	26.40	0.1972	8.048	14.52	2.171
$C\,i\,V$	0.3858	0.4681	0.5854	0.544	0.3642	0.3109	0.5411
Background value	0.056	11.4	28.9	0.040	34.8	8.4	7.1

The results reveal that: According to Table X, the average heavy metal content of Huizhou Danao flood diversion channel and Baishou Bay generally exceeds the soil background value of Guangdong Province, and the content of heavy metals Hg, Cu, Pb, Cd and Ni exceed the background values by 2.54 times, 3.27 times 1.56 times, 9.06 times and 5.56 times. However, the heavy metals have small variation coefficients, indicating small degree of dispersion in the mean per unit with less interference of human activities and unserious pollution.

V CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

Based on result analysis of the above four evaluation methods, seen from the perspective of spatial distribution characteristics, both high value points and low value points appear. The reason is that the high value point sampling site is located in the main stream, that is, the downstream of sewage outlet of East Gate Bridge project, while the low value point sampling site is located at upstream of the intersection, i.e. at the confluence of Xiangshui River and Danao flood diversion channel in Daya Bay as well as Baishou Bay Marine Ecosystem Reserve. It suggests that on the one hand, the tributary exerts a great impact on the main stream, on the other hand, the main stream has certain self-purification capacity. According to the results, heavy metals in the sediments of Huizhou Danao flood diversion channel and Baishou Bay are not seriously polluted, belonging to light pollution. The main source of pollution is the wastewater discharged from the sewage treatment plant and East Gate Bridge project.

5.2 Recommendations

(1) Treatment from the source: It is necessary to seriously investigate the hidden environmental safety hazards of heavy metal pollution enterprises, especially those with backward technology and serious pollution, so that the hidden pollution hazards are resolutely eradicated in the bud. The regulations and standards system should be improved as a prerequisite for accepting and approving environmental impact assessment documents of heavy metal industry-related construction projects in the area.

(2) Clean production: The epidemic may also change human attitudes towards land, "the future well-being of human beings depends on our behavior shift from reducing cultivated land, poisoning soil to increasing cultivated land and purifying soil". The total discharge amount of heavy metal should be strictly

controlled in new construction, reconstruction and expansion of large-scale smelting projects. Industrial water circulation system should be renovated to increase the industrial water circulation rate. Enterprise production water supply should be reasonably allocated, and cascade use of process water is advocated. Technical level of industrial wastewater treatment should be improved so that processed wastewater is reused for production systems. Efforts should be made to strengthen the research on clean production-related key technologies as well as the promotion and application of existing advanced technologies, accelerate the technological progress of the industry, thereby improving development quality and efficiency of the industry.

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REFERENCES

[1] Tian CX, Li WM, Zheng CY (2011) Research progress in heavy metals of rivers. Journal of Qinghai Normal University 4

[2] Blaudez D, Botton B, Chalot M (2000) Cadmium uptake and subcellular compartmentation in the ectomycorrhizal fungus Paxillus involutus. Micro- biology 146:1109–1117

[3] Zhang K (2010) Research progress in pollution control technology for heavy metals in water. Journal of Environmental Management College of China 20(3):62-23

[4] Larsson EH, Asp H, Bornman JF (2002) Influence of prior Cd2+ exposure on the uptake of Cd2+ and other elements in the phytochelatin-deficient mutant, cad1-3, of Arabidopsis thaliana. J. Exp. Bot. 53:447–453

[5] Geng YN (2012) Research progress in heavy metal pollution of rivers. Chinese Agricultural Science Bulletin 28(11):262-265

[6] Lombi E, Zhao FJ, McGrath SP, Young SD, Sacchi GE (2001) Physi-ological evidence for a high-affinity cadmium transporter highly expressed in a Thlaspi caerulescens ecotype. New Phytol. 149:53–60

[7] Baidu Tourism (2017) Huizhou Tourism. Available at: http://lvyou.baidu.com/guangdonghuizhou/

[8] Huizhou. CN. Daya Bay Current Affairs. Http://e.hznews.com/paper/hzrb/20120420/A10/4/

[9] Lu RK (2005) Soil agricultural chemical analysis method. Beijing: Science Press 237-242

[10] National Environmental Protection Agency (1995) Soil Quality Evaluation. Beijing: China Environment Press 16-20

[11] General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China. (2002) Quality of marine sediments. Beijing: China Standard Press

[12] Sterckeman T, Perriguey J, Cae¨l M, Schwartz C, Morel JL (2004) Apply- ing a mechanistic model to cadmium uptake by Zea mays and Thlaspi caerulescens: consequences for the assessment of the soil quantity and capacity factors. Plant Soil 262:289–302

[13] Chu HJ, Lin YP, Jang CS, Chang TK (2010) Delineating the hazard zone of multiple soil pollutants by multivariate indicator kriging and conditioned Latin hypercube sampling. Geoderma. 158:242-51

[14] Liu Q, Pan WB (2008) Environmental Quality Evaluation. Guangzhou: South China University of Technology Press 36-37

[15] Fan SX (2011) Soil heavy metal pollution and control. Beijing: China Environmental Science Press 154-165

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[16] Xu ZQ, Ni SJ, Zhang CJ, Tuo XG, Teng YG (2004) Application of pollution load index method to evaluate heavy metals in the sediments of Jinsha River in Panzhihua area. Sichuan Environment 23(3):64-67
[17] Men BH, Liang C (2005) Attribute recognition model of water quality evaluation based on weight of variation coefficient. Journal of Harbin Institute of Technology (10):69-71