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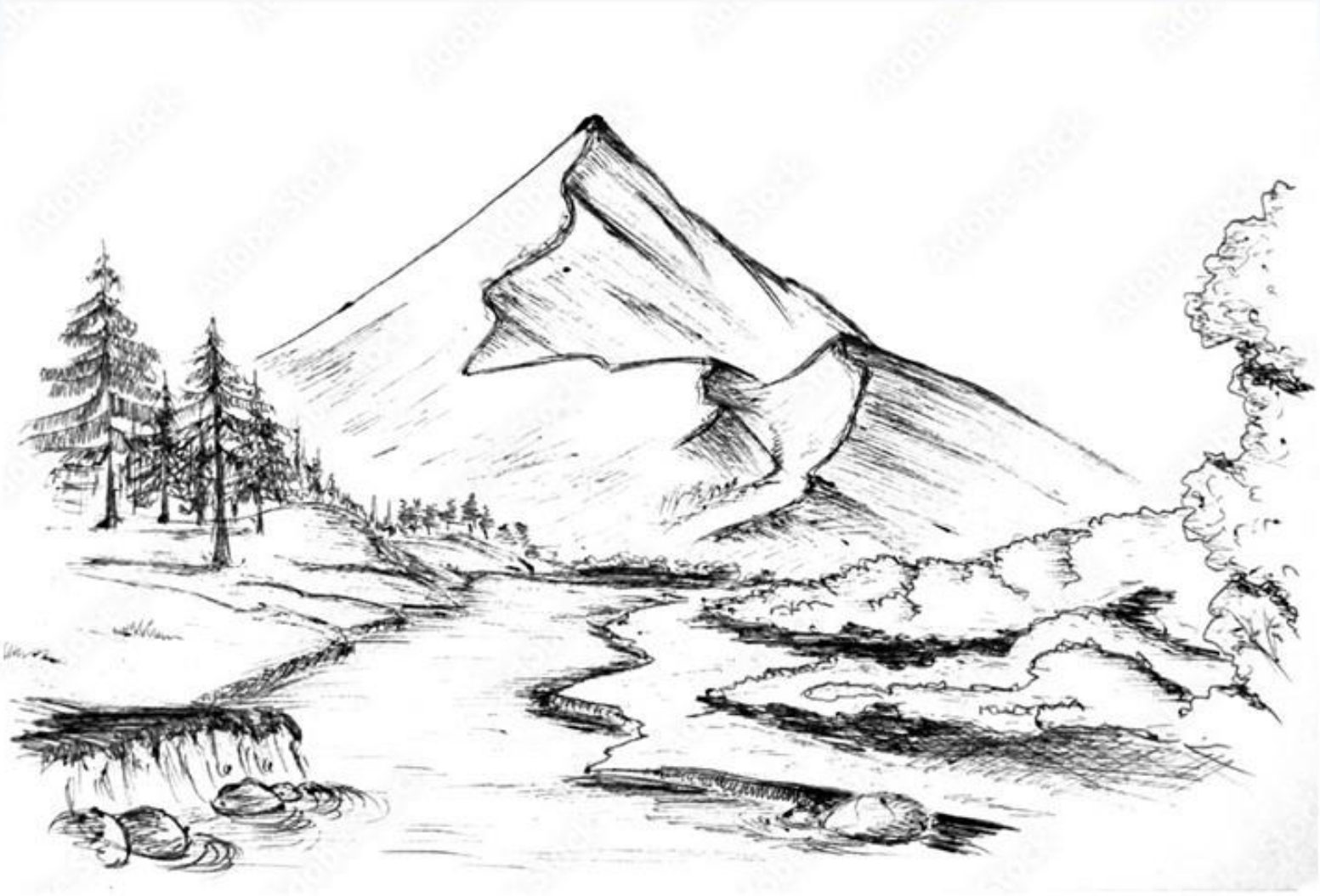
Ngoc T. NGUYEN, Anh Q. NGUYEN, Toan. D. VU, Phi Q. NGUYEN, Tien L.T. DU,
Nuong T. BUI, Thao. T. P. BUI, Tra T. NGUYEN, Dan D. BUI



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Editors:
Ngoc T. NGUYEN
Anh Q. NGUYEN
Toan. D. VU
Phi Q. NGUYEN
Tien L.T. DU
Nuong T. BUI
Thao. T. P. BUI
Tra T. NGUYEN
Dan D. BUI

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PREFACE

On behalf of the Organizing Committee, I warmly welcome you to the 12th edition of the VIETWATER 2022 and Vietnam International Water Conference (VIWC 2022) in the most dynamic city of Vietnam, Ho Chi Minh City.

Having a dense river network with more than 2,300 rivers, Vietnam has more than 800 billion cubic meters each year. However, two thirds of the surface water resources originate from outside of the country. More than 70% of the water is generated in less than four months of the wet season. Urban populations have increased more than 80% from 1990 to 2020, making up almost 40% of the total populations. Rising demands, rapid urbanization, increasing pollution, outdated water technologies and infrastructures, and unequal access to safe water and sanitation can severely jeopardize the sustainable development of this world top growing country.

"Too much, too little and too dirty" water problems have further been exacerbated by the evident climate crisis. Record temperatures, wildfires, droughts and floods have been broken around the world. The most recent catastrophic floods submerged a third of the entire Pakistan country. It is the wake-up call for the world to act as the U.N. Secretary-General Antonio Gutteres has said, "Today, it's Pakistan. Tomorrow, it could be your country". At the 2021 United Nations Climate Change Conference (COP26) in Glasgow, Vietnam's Prime Minister Pham Minh Chinh stated that Vietnam will reach its net-zero carbon emission target by 2050 and called for fairness and justice in climate change issues. Furthermore, Political Bureau of the Party Central Committee of Vietnam have issued the Politburo's Conclusion 36-KL/TW for ensuring national water security, reservoir and dam safety till 2030 with vision 2045.

The collaboration between countries and between stakeholders is thus imperative to develop and implement the latest technologies and innovations in the water industry. I thus strongly believe that VIETWATER 2022 is an excellent platform that can bring the world leading technologies, innovations, minds, and related stakeholders to tailor the solutions addressing the local problems in your countries, cities, neighborhoods, and your backyards.

At this occassion, you are heartily welcome to enjoy the only close-up experience in Vietnam of the cutting-edge VIETWATER Expo in water supply, sanitation, and purification technologies, the leading WETV Expo in waste and environment technologies, and the innovative PROPAK Expo in processing and packaging solutions. In parallel with the expo, you are warmly invited to meet the world leading scientists and experts in water, environment, and geosciences at VIWC2022 to customize the global solutions to your local issues where sciences, technology and innovation meet to build the future of localities.

Best regards,

Sci. Dpl. Glenn Banaguas

Chairman, US-ASEAN Fellows for Science and Technology
Chairman, ASEAN Science Diplomats
United Nations (UN) Sasakawa Award Winner 2022

Assessment of environmetntal pollution levels and forecast of changes in some heavy metals and grease in sediment of Nam Cau Trang Port cluster - Quang Ninh Province

Phuong Nguyen[1,*], Cuc Thi Nguyen [2], Lan Anh Thi Vu[2], Dong Phuong Nguyen[2], Hoang Hai Yen[3]

[1]General Association of Geology of Vietnam
[2] Ha Noi University of Mining and Geology, Viet Nam
[3] Mining and Geology Construction and Technology Deployment Consulting Company

1. Introduction

The study area has many valuable natural resources, including Ha Long Bay, Bai Tu Long National Park, many estuaries, and deep-water bays. Sea encroachment to expand land fund, planning industrial zones, seaports, factories, urban areas, transportation, and mineral exploitation is the main cause of seawater quality degradation and depression, coastal area. Aquaculture activities, fishing activities, fishing activities, fisheries services, and tourism activities are also sources of water and sediment pollution in NCT Port Cluster.

Population growth and industrial, urban, and tourism growth have significantly increased pollution emissions, causing direct pressure on the natural environment and a significant impact on biodiversity and porcelain, healthy community, including NCT Port Cluster area.

Therefore, the assessing the current situation and forecasting environmental changes; The focus is on heavy metal and oil elements in seawater and coastal sediments in Quang Ninh province in general and NCT Port Cluster area in particular, is necessary and important in the orientation of economic - society, ensuring sustainable development goals.

The article introduces several research results on the assessment of the current state and forecasts of environmental changes in the sediments of NCT Port Cluster on the basis of the combined application of statistical models and key factor analysis methods; thereby proposing solutions to prevent and minimize negative impacts from human activities on the environment and measures to improve the efficiency of environmental state management in the NCT Port Cluster, Quang Ninh Province.

2. Materials and methods

2.1. Materials and scope of study

NCT Port Cluster is located in Hong Ha Ward. Its topography is mainly hilly, limestone mountains (Nui Dam), and earth hills in the North of the ward. The region's topography is high in the north and lowers in the south. Due to socio-economic development requirements, a part of the wetlands and tidal flats in the south of the ward have gradually been converted to use purposes into new urban areas.

Population growth and industrial development (including mining activities), and urbanization have been putting direct and increasing pressure on the coastal water and sediment environments. Quang Ninh province in general, NCT port cluster in particular.

The risk of pollution of the quality of seawater and coastal sediments is also due to the operation of fishing villages on the sea as well as wastewater and domestic waste from coastal residential areas that have not been thoroughly controlled.

Pollutants discharged into the study area are often in two main ways, due to the washing of the pollution sources on the mainland through the river, stream, creek system, tide to the bay and directly from the domestic wastewater, coastal residents, tourists, aquaculture, water transport activities, etc.

2.2. Research Methods

2.2.1. Outdoor method

Field survey, collecting documents on the current state of water, soil and air environment at some points in the area of the NCT port cluster in Quang Ninh. The locations of samples collected in sediments NCT Port Cluster, Quang Ninh Province with the analysis results of heavy metals and grease used in the paper are shown in Figure 1.

Figure 1. Sampling location

2.2.2. Collection and synthesis of documents

Collecting and synthesizing documents collected from previous works [2,4]; selecting documents to ensure reliability to handle in order to improve the effectiveness of the assessment of the current environmental situation and forecast the sediment environment fluctuations.

2.2.3. Document handling

a. Statistical method

- *One-way statistical method:* One-dimensional statistical model allows to describe of the statistical distribution law of certain environmental parameters (indicators).

- *Two-dimensional statistical method*: The content of heavy metals and grease in sediments often varies greatly by location, possibly close to the natural content or thousands of times higher, depending on the location taken sample and source of pollution. The concentration of heavy metals tends to decrease gradually from shore to sea, from inside the channel to the waterway transport route.

Correlation coefficient reflects the relationship between two environmental parameters (criteria) x, y, denoted by R_{xy} and is determined by the formula:

$$R_{xy} = \frac{\sum_{i=1}^{n} x_i y_i - \frac{1}{N}\sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{\sqrt{\left[\sum_{i=1}^{n} x_i^2 - \frac{1}{N}\left(\sum_{i=1}^{n} x_i\right)^2\right]\left[\sum_{i=1}^{n} y_i^2 - \frac{1}{N}\left(\sum_{i=1}^{n} y_i\right)^2\right]}} \quad (1)$$

In which: x_i; y_i is the value of parameter x and y in the ith sample (monitoring point); n is the number of samples (points) studied. For highly reliable prediction, the correlation coefficient needs to be large ($R_{xy} \geq 0.7$).

b. Main ingredient analysis method

Assuming each research object (soil, water, air), we only need to consider two main components Y and Z, characteristic of some pollution level out of the *m* indicator, is enough, i.e. The original document match ($T_{n\times m}$) only needs two columns and n rows corresponding to *n* objects (sampling point). Then, if we represent the object on the correlation field with X and Y axis, we can imagine the uniformity level of the object of study. To evaluate the uniformity of the sample set and search for the most important indicators among the m indicators, people often use the analysis of main factors [Nguyen Phuong, Nguyen Quoc Phi (2018)].

Assuming the base matrix T has m columns, that is, there are m symbols x_1, x_2,... x_m and are all centered with a covariance matrix $[Sij]_{mxm}$, then we find a new variable Y is a linear combination of m initial variables x_1, x_2,..., x_n in the form of the following general equation:

$$Y = \sum_{i=1}^{m} b_i x_i \qquad (2)$$

The requirement is to determine the b_i coefficients such that variable Y contains the most initial information. In addition, for the variable Y to be unique, the following conditions must be met: $\sum_{i=1}^{m} b_i^2 = 1$ (3)

If the symbol p is a vector with components (b_1, b_2,..., b_m), then the vector to be found is called the eigenvector corresponding to the maximum *p* value of the covariance matrix $[Sij]_{mxm}$, determined by the equation: $(S- \lambda l)p = 0$ (4)

Similarly, we consider adding a new variable Z which is a linear combination of the original variables in the form of an equation: $Z = \sum_{i=1}^{m} c_i x_i$ (5)

Equation 5 must satisfy the following conditions: It contains many parameters about the original data and satisfies the condition that is the only variable: $\sum_{i=1}^{m} c_i^2 = 1$ (6)

The component variable Z must satisfy the orthogonal condition with component Y.

Let γ be the eigenvectors of the components (c_1, c_2,..., c_m), then the vector is also the eigenvector corresponding to the second eigenvalue of the covariance matrix $[Sij]_{mxm}$, i.e. was:

$$(S- \lambda l)\gamma = 0 \qquad (7)$$

In general, if the random variable X has m dimensional, the expectation is 0, then the covariance matrix $[Sij]_{mxm}$ has an orthogonal transformation: $U = p'X$ (8)

Such that the variance matrix of U is diagonal with the molecules λ_i is the solution of Equation 8. The $U_k = p_k \cdot X$ component is orthogonal and is called the main factor. In addition, the random variable U received through the orthogonal transformation will preserve the variance, that is: $\sigma^2_y + \sigma^2_z = \sigma^2_x + \sigma^2_y = \text{const}$ (9)

Thus, the determinant of the corresponding covariance matrix U is also |S|.

3. Results and discussion

3.1. Statistical distribution characteristics and correlation relationship between metallic elements and grease in sediments in the NCT area, Quang Ninh Province

The results of the treatment of the statistical characteristics of the content of heavy metals and oil elements in the sediments of NCT port cluster are summarized in Table 1.

Table 1. The statistical characteristic parameters of the content of heavy metal elements and oil and grease in the sediments of the NCT port cluster

Element	Content ($mg.kg^{-1}$)			Variance (σ^2)	Coefficient of variation (V%)	QCVN 43:2017 /BTNMT
	Min	Max	Average			
As	16.8	39.6	25.8	89.38	36.6	41.60
Hg	1.3	2.7	1.9	0.24	26.1	0.70
Pb	113.5	289.2	169.9	3612.9	35.4	112.00
Cd	0.06	0.26	0.15	0.0058	54.6	4.20
Grease	65	461	205.9	17141.7	63.6	-

Based on the original document (analytical results), calculate the Z values for all samples and the results summarized in Table 2, 3.

Table 2. Results of calculation of rated component (t) of elements

N^0	As	Hg	Pb	Cd	Grease
	t_1	t_2	t_3	t_4	t_5
1	0.909	0.393	2.027	1.433	0.498
2	0.640	1.128	2.120	1.298	0.527
3	-0.872	-1.075	-0.762	-0.721	-0.690
4	-0.914	-0.708	-0.790	-0.856	-0.617
5	1.427	1.311	0.533	0.894	0.936
6	1.230	1.495	0.409	1.164	0.805
7	-0.872	-0.892	-0.706	-0.991	-0.741
8	-0.810	-1.075	-0.681	-0.856	-0.719
9	-0.769	-0.525	-0.639	-0.721	-0.814
10	-0.644	-0.708	-0.566	-0.856	-0.836
11	1.220	1.128	0.141	1.029	1.752
12	1.137	0.944	0.288	0.760	1.716

Table 3. Results of Z value calculation for the Main ingredient

As	Hg	Pb	Cd	Grease
t_1	t_2	t_3	t_4	t_5
2.301	1.382	0.352	-0.266	0.036
2.499	1.329	-0.123	0.356	-0.009
-1.845	-0.008	0.248	-0.127	-0.137
-1.738	-0.155	0.025	0.151	-0.079
2.311	-0.434	-0.339	-0.148	0.233
2.323	-0.418	-0.549	-0.102	-0.129
-1.887	-0.024	0.079	0.056	0.080
-1.860	0.033	0.230	-0.111	0.026
-1.550	0.014	-0.222	0.061	-0.062
-1.620	0.069	-0.109	-0.054	0.141
2.397	-1.027	0.296	0.055	-0.098
2.191	-0.882	0.425	0.138	0.116

13	-0.872	-0.892	-0.722	-0.721	-0.887	-1.832	0.079	-0.009	-0.099	-0.132
14	-0.810	-0.525	-0.651	-0.856	-0.931	-1.689	-0.549	-0.559	-1.658	1.493
□						4.423	0.455	0.084	0.025	0.012

Based on Table 3, determine the distribution of sediment sampling points according to the new coordinate system, ie according to the two main criteria identified above, namely As and Hg (Figure 2).

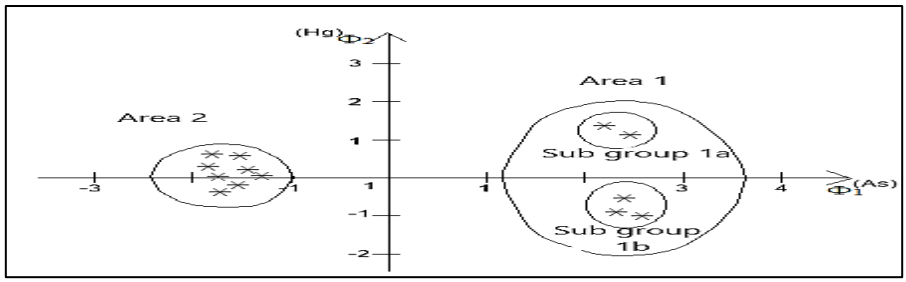

Figure 2. Position of sampling points on the new coordinate system identified by 2 main components (main indicator) As and Hg

In Figure 2, sampling points are divided into 2 Areas (2 groups) (Figure 1):

- The content of the elements As, Hg, Pb, Cd and grease in area 1 (group 01 - along the waterway) is 1.6 (Pb) to 3.8 times higher (grease). Compared with the average content of samples in area 2 (group 2) and the average content of elements Hg, Pb and grease all exceed the National Technical Regulation on Sediment Quality Standards (QCVN 43:2017/BTNMT) from 1.8 to 3.5 times.

- The average content of As, Hg, Pb, Cd and grease in area 2 (group 2) is lower than group 1, but the average content of Hg and Pb also exceeds the Sediment Quality Standards (QCVN43:2017/BTNMT).

3.3. Solutions to prevent and minimize environmental impacts

To ensure sustainability in the operation of the NCT Port cluster, Quang Ninh Province, according to the author, some solutions should be concentrated as follows:

- Strengthen periodic environmental monitoring, analysis and research and export batch; for indicators of grease and heavy metals, the monitoring frequency should be once a month.

- Constructing works to prevent surface washout, landslide of landfill sites in mineral exploitation areas, coal export ports. Enterprises are required to invest in the installation of advanced waste treatment systems, in order to limit the load and ensure the concentration of waste must be below the permitted level before being discharged into the environment.

4. Conclusion

The area of the NCT port cluster has environmental characteristics typical of the bay area, with a complicated coastline direction and many impacts from human activities. Most of the drainage systems to the study area in particular, Ha Long Bay in general, flow through industrial zones, ports, and residential areas.

The pollution of heavy metals and grease in the bottom sediments of NCT port cluster at the time of the study is tending to increase and is complicated by the emission sources have not been thoroughly controlled. At the time of assessment, the average content of Hg, Pb and grease in NCT port cluster sediments all exceeded the permitted norms (QCVN 43:2017/BTNMT).

The results of grouping based on the analysis of the main components of the study area are divided into 2 areas with specific characteristics.

NCT port cluster area is adjacent to Ha Long Bay; at the time of research, the bottom sediments have been and are being polluted with mineral oil and some heavy metals content (As, Hg, Pb). To ensure sustainable development, in the short term, it is necessary to focus on a number of overall solutions on environmental policies and management, combining solutions to socialize environmental protection with instrumental solutions, providing economic support to harmonize benefits between mineral exploitation, water transport with other activities that are effective and sustainable development.

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