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Determination method of environmental damage liability insurance underwriting coverage of offshore factory wastewater based on OTUS

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ABSTRACT

With the rapid development of the world's economy, the ocean has a higher carrying capacity, but the marine pollution is becoming more and more serious. Human activities, such as marine oil spill, coastal industrial pollutant discharge and domestic waste discharge, have seriously affected the marine ecological health. In order to determine the pollution scope of coastal factories' wastewater discharge and to determine the coverage of environmental damage liability, this study constructed the genetic algorithm improved maximum inter class variance method (OTSU) to analyze the pollution range of wastewater. Firstly, the insurance coverage of offshore factory wastewater pollution is analyzed; secondly, the genetic algorithm is used to improve the two-dimensional maximum entropy algorithm, which is used to process the marine wastewater image transmitted by the monitoring station; finally, the query system of the environmental damage liability scope of the factory wastewater is constructed. Through the test of the improved algorithm and system, the results show that the centroid deviation distance of the algorithm is 0.30–1.60 m, which is better than other algorithms. After FCM clustering algorithm processing, the centroid deviation distance is further reduced. The algorithm established in this study is feasible and can help the insurer and the insured to determine the scope of contract.

Keywords: OTSU; Offshore plant; Industrial wastewater; Marine pollution; Underwriting coverage

1. Introduction

The discharge of industrial polluted wastewater is an important factor affecting the marine environment, which not only relates to the balance of marine ecology, but also affects the living environment of human beings. The sea area polluted by industrial wastewater needs to be recovered for a long time, and the recovery cost is very high [1]. Many countries lack perfect and strict compensation system for marine environmental damage, so when the marine environment is damaged, there is no corresponding system to claim compensation from the polluter. In recent years, environmental liability insurance is an effective measure to reduce the operational risk of enterprises and improve the compensation cost of environmental governance. However, there is no uniform standard for the definition of contracting scope in the popular environmental liability insurance in various countries, and the coverage stipulated by many countries remains unchanged [2]. It can be seen that the contracting scope of environmental liability insurance is different from the general explicit policies and decrees. It is a process of policy selection. Offshore factories have a long duration of sewage discharge, and the pollution to the sea comes from multiple individuals, which belongs to progressive pollution. Whether the environmental pollution control cost of such pollution should be included in the scope of environmental liability insurance is one of the hot topics in academic circles, and the regulations of

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different countries are also different [3]. Based on the externality effect of economics, lemon market effect and game analysis theory, it is considered that progressive pollution is insurable. This study will explore the coverage of environmental liability damage through quantitative analysis of the pollution scope of offshore factory wastewater.

In this study, genetic algorithm (GA) is used to improve the two-dimensional maximum entropy image segmentation algorithm to process the initial image obtained from the monitoring station of industrial wastewater pollution. Compared with the one-dimensional threshold segmentation algorithm, the two-dimensional threshold image segmentation algorithm not only considers the one-dimensional characteristics of the image gray histogram, but also takes into account the spatial neighborhood information of the pixel space, which reduces the computational complexity and improves the operation efficiency. The two-dimensional threshold image segmentation algorithm is the improvement of two-dimensional OTUS algorithm. The concept of "entropy" is added in the process of image segmentation, which can evaluate the quality of image segmentation results. Combined with genetic algorithm, the optimal threshold can be optimized to obtain high-quality wastewater pollution image.

The innovation of this study is to use the concept of entropy and genetic algorithm to improve the traditional OTUS algorithm. When the pixels of the industrial wastewater pollution image monitored by the monitoring station are low, when the pollution degree is serious, the pollution range is large, and the external boundary area of the pollution area is fuzzy, which requires the image processing calculation to have high accuracy. When the two-dimensional maximum entropy image segmentation algorithm is used to process the image, the optimization of the optimal threshold value is added in the operation, and the high-precision processing of the wastewater pollution image can be realized.

This paper expounds the research results from four aspects. The first part summarizes and analyzes the research on industrial wastewater pollution at home and abroad in recent years. The second part introduces the coverage of environmental liability insurance, and determines the research direction according to the analysis results of the contract scope; uses GA algorithm to further optimize the improved two-dimensional Otsu algorithm to deal with the wastewater pollution image; constructs the query system for the environmental liability contract scope of offshore factory wastewater pollution. The third part is to analyze the improved two-dimensional Otsu algorithm and test the system performance. The last part is the summary and reflection of this study.

2. Related works

Díaz-Méndez et al. [4] have studied the mutagenic activation of aromatic amines by S9 components of mollusks. It is considered that the mutagenic activation of aromatic amines by S9 can be used as a reliable biomarker of marine pollution. The concentration of artificial styrene oligomer found by Kwon et al. [5] around the world is higher than the expected concentration based on PS stability. It seems to exist in different degrees in seawater and sand samples collected from beaches around the world, and it is a global beach pollutant. Tonacci et al. [6] have proposed a real-time assessment model of sea surface pollutants based on autonomous underwater vehicle network. The system is equipped with sensors to detect volatile organic compounds produced by hydrocarbons, which can be used in integrated marine monitoring tools. Sakthi Priya et al. [7] used a biosurfactant producing microorganism *Bacillus subtilis* to degrade offshore crude oil. The degradation rate and viscosity reduction rate of crude oil in 10 days were 80% and 60%, respectively. This microorganism has great potential in oil spill control. Tiquio et al. [8] described and compared coastal and marine pollution management frameworks in Europe and Southeast Asia. Through comparative analysis, it is considered that although EU member states have encountered challenges in complying with EU directives, it is necessary for sea to take actions to adopt and implement a similar regional legal framework to effectively manage coastal and marine pollution issues. Through data analysis of more than 10,000 pollution incidents in the exclusive economic zones of 25 Pacific countries and territories and in international waters between 2003 and 2015, Richardson K's team emphasized the development of a regional outreach and compliance assistance program on marine pollution prevention and improvement of waste receiving facilities in Pacific ports [9].

According to the structural parameters and capillary mechanism of fabrics, Seddighi and Hejazi [10] established a mathematical model for oil recovery of industrial textiles, and prepared 11 kinds of commercial industrial textiles with different properties. The absorption capacity of fabric samples with different processes was obtained, and the theoretical calculation value was in good agreement with the experimental value. Chen and other scholars analyzed the decoupling relationship between marine pollution and economic growth in China from 2002 to 2013. The results show that when the area of coastal red tide disaster is taken as the marine pollution index, the relationship between pollution and growth is inverted n-type [11]. Polidoro et al. [12] provided baseline information on the presence and concentration of heavy metals and selected organic pollutants (pesticides, polycyclic aromatic hydrocarbons, and phthalates) in seven coastal rivers and surface water near the Futian landfill site in American Samoa, providing data reference for improving the status of local fresh water and coastal resources. Xu et al. [13] studied the feasibility of using the size difference of planktonic ciliates for biological assessment of water pollution based on the modified hierarchical structure of body shape unit characteristics. The results show that. The measurement method of body type diversity based on ciliate characteristic grade can be used as a potential indicator of marine pollution. Lukyanova et al. [14] used the embryogenesis of sea urchin as a biological indicator of sea water quality in the Sea of Japan/East China Sea and Okhotsk Sea, and considered that the eggs, embryos and larvae of sea urchins are suitable biological indicators for early disturbance of marine pollution in the ecosystem. Ambuselvan's team studied the distribution of heavy metals in the surface sediments of the Coromandel Coast in the Bay of Bengal as an indicator of marine pollution. Factor analysis showed that the accumulation of these heavy metals in the shelf sediments was due to human input from the adjacent land area [15].

The above analysis on the pollution control of industrial wastewater in the sea area mostly focuses on the biological methods of wastewater treatment and the economic indicators of the degree of marine pollution. However, the research on the contracting scope of environmental liability insurance for wastewater pollution treatment is still relatively limited. In view of this, the scope of industrial wastewater pollution from offshore factories will be quantitatively analyzed by analyzing the contract scope of existing environmental liability insurance [16].

3. Monitoring model of environmental damage range of offshore factory wastewater

3.1. Legal system of compulsory liability insurance for environmental pollution

The coverage of environmental liability insurance refers to the insurance object and scope covered by the environmental liability insurance system. It is the core issue to be considered in the formulation of insurance policies and legal design, and is directly related to the settlement of environmental liability insurance claims and litigation disputes that may arise in the future. There is no unified model for the contract scope of environmental liability insurance policies in various countries. The determination of contract scope includes many factors, such as the degree of environmental damage, the underwriting capacity of insurance companies, the level of risk management, etc.

The wastewater discharge behavior of offshore factories belongs to progressive pollution, which is complicated, and the pollution result is caused by multiple factors; this kind of pollution has a long-term nature, and the pollutants need to accumulate for a period of time before causing obvious damage accidents; the individuals causing such pollution have a high correlation, and finally are superimposed by individual pollution from different sources The results show that the individual economic activities that cause pollution are legitimate, and these enterprises have emission rights in law; the losses caused by pollution are uncertain, but the amount is large, the degree is deep and the scope is wide in Fig. 1.

The contract scope of ecological risk damage includes ecological environment damage, spiritual damage compensation, emergency disposal and pollution removal costs and litigation costs. Progressive pollution does not cover mental damage. The insured amount of litigation costs is determined by the court after examining the interests of both the applicant and the insurer according to the rationality benchmark. The specific amount of insurance for emergency disposal and pollution removal and ecological environment damage costs needs a large number of scientific and accurate data to estimate and evaluate the risk probability and degree of ecological environment damage compensation. The specific work flow of the appraisal and evaluation process is shown in Fig. 1 It is shown that. Only when the degree of damage to the ecological environment and control measures are determined can the corresponding rate be determined. Therefore, it is particularly important to determine the degree and consequence of progressive pollution,

3.2. Construction of marine wastewater pollution monitoring data analysis system

In determining the specific rate of the environmental damage liability coverage of wastewater, the relevant departments will conduct real-time monitoring on the content of marine wastewater through the on-line monitoring system of marine sewage. There is no chemical reagent and secondary pollution in the whole process of monitoring, and the on-site explosion-proof design meets the national explosion-proof field application requirements. In this study, the detection data transmitted by the monitoring station of marine wastewater pollution detection by fluorescence method is selected. The measurement accuracy of this method is high, and the interference of plankton on the surface can be avoided.

In this study, OTUS image segmentation algorithm is used to automatically identify the pollution area of offshore area, instead of the traditional artificial recognition mode. The range of the region to be recognized is determined by image threshold segmentation method. One dimensional OTUS image segmentation algorithm uses enumeration method to determine the gray level of the image to be processed when the value of the objective function is maximum, so as to find the image segmentation threshold. However, this method is sensitive to noise points and cannot accurately filter noise interference. Therefore, this study uses two-dimensional OTUS image segmentation algorithm to segment the original image threshold to determine the pollution range.

For an image I of size $M \times N$, the gray level of its gray value and neighborhood average gray value at the initial moment are l, which are represented by $l(x,y)$ and $g(x,y)$ respectively. If the neighborhood window is set to 3 × 3, then:

$$g(x,y) = \frac{1}{9}\sum_{m=-1}^{1}\sum_{n=-1}^{1} l(x+m, y+n) \tag{1}$$

Eq. (1) is the calculation formula of the average gray value of the neighborhood, $x+m \in (0,M)$, $y+n \in (0,N)$:

$$p_{lg} = \frac{f_{lg}}{M \times N} \tag{2}$$

Eq. (2) is the expression of joint probability density p_{lg}. the frequency of gray value l and neighborhood average gray level g in the target image is f_{lg}.

The two-dimensional gray histogram of the target image consists of four parts: 1, 2, 3 and 4, which are segmented by the gray level s of the center point of the neighborhood and the average gray level t of the neighborhood. Regions 1 and 2 are located in the diagonal position, which are the target region and the background region, while the regions 3 and 4 far away from the histogram are noise regions:

$$p_t = \sum_{l=0}^{s}\sum_{g=0}^{t} p_{lg} \tag{3}$$

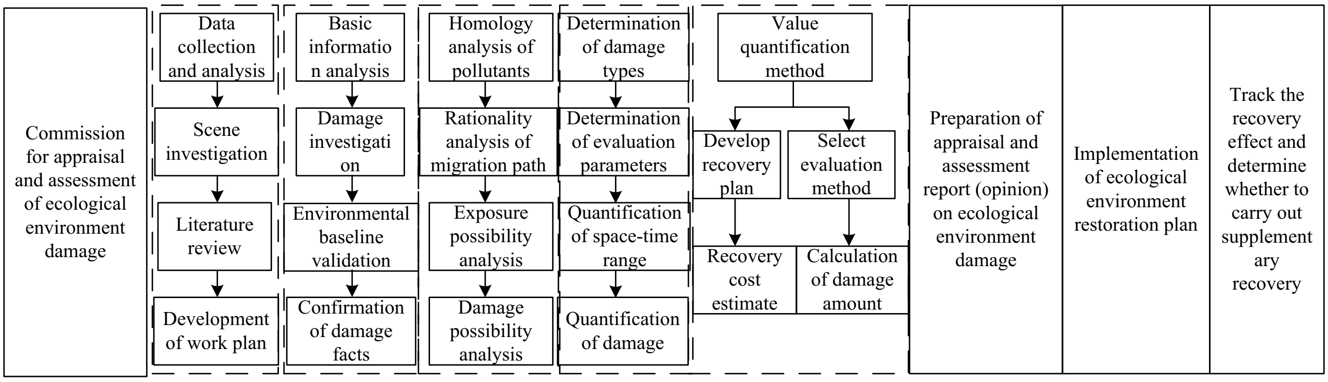

Fig. 1. Ecological damage assessment process.

$$p_b = \sum_{l=s+1}^{L-1} \sum_{g=t+1}^{L-1} p_{lg} \tag{4}$$

Eq. (3) is the calculation formula of probability distribution p_t of target area, and Eq. (4) is the calculation formula of probability distribution p_b of background area.

Through Eqs. (3) and (4), the mean vector u_A of the two-dimensional histogram can be calculated.

$$u_A = (u_{Ai}, u_{Aj})^T = \left[\sum_{l=0}^{L-1} \sum_{g=0}^{L-1} l p_{lg}, \sum_{l=0}^{L-1} \sum_{g=0}^{L-1} g p_{lg} \right]^T \tag{5}$$

Since the probability of distribution of the noise points far away from the diagonal of the image in the two-dimensional histogram is small, the noise points far away from the diagonal line are ignored in this study, hypothesis $p_t + p_b = 1$.

$$J(s,t) = p_t \left[\left(u_{ti} - u_{Ai}\right)^2 + \left(u_{tj} - u_{Aj}\right)^2 \right] + p_b \left[\left(u_{bi} - u_{Ai}\right)^2 + \left(u_{bi} - u_{Ai}\right)^2 \right] \tag{6}$$

The objective function calculation formula of two-dimensional OTSU algorithm is shown in Eq. (6). The optimal threshold value is (s,t), and the value of objective function $J(s,t)$ is the largest.

The image segmentation algorithm based on two-dimensional maximum entropy threshold introduces the concept of entropy, which is used to measure the quality of image segmentation. In the process of image quality assessment, because the noise and edge information represented by regions 3 and 4 have little influence on the image segmentation quality, only the entropy values of the target region and the background region represented by region 1 and 2 are considered. The traditional two-dimensional threshold image segmentation algorithm uses the form of cycle nesting, which makes the threshold s and t traverse the gray range of the image, and verifies the gray value of each part. This method has a large amount of calculation and takes a long time. Genetic algorithm is used to improve the two-dimensional threshold image segmentation algorithm proposed above. The genetic algorithm uses eight bit binary coding. The threshold pairs s and t can be represented by vector $a = [t_1, t_2, t_3, \ldots, t_8, \ldots, t_{16}]$. The first eight bits are the binary coding of the first threshold, and the last eight bits are the binary coding of the second threshold. When the two-dimensional threshold segmentation algorithm based on genetic algorithm optimizes the optimal threshold, it uses the form of crossover operator and mutation operator to provide new data for the operation database, which increases the diversity, so as to find the feasible solution of the problem in the global scope and avoid falling into the local optimal situation in Fig. 2.

The flow chart of the improved two-dimensional threshold segmentation algorithm based on genetic algorithm is shown in Fig. 2. The segmentation threshold is set to 8-bit binary code, and the number of population individuals is 30–50. The fitness function of the algorithm is the corresponding function of the optimal threshold, namely Eq. (6). If the iteration condition is satisfied, the individual is the optimal one; otherwise, the selection, crossover and mutation operations of genetic algorithm are performed to form a new offspring population, and the fitness function of the new offspring population is recalculated until the optimal individual is selected.

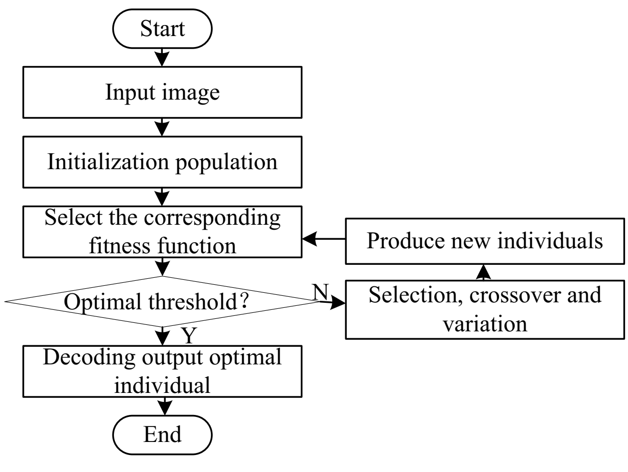

Fig. 2. Flow chart of two dimensional threshold image segmentation algorithm based on genetic algorithm.

3.3. ERT pollution monitoring data analysis system

This study designs the overall scheme of the monitoring data analysis system of marine wastewater pollution, and presents the specific situation of the offshore factory wastewater pollution in the form of information portal system. The system is divided into seven parts: login registration module, project actual situation viewing module, image data management and analysis module, initial image processing module and initial data processing module, system setting module. The module function and system use path are shown in Fig. 3.

User login registration module is the portal module of data analysis system, ordinary users need to register; visitors directly log in to the system; administrators specify through the system background. The project actual situation viewing module is mainly responsible for assisting the administrator to remotely monitor and detect the site weather, geographic positioning, measuring the length of the initial image line and other information, so as to facilitate the relevant personnel to master the project situation at a macro level. The data management and analysis module can realize the visualization of data information and save and manage the initial data and geochemical data. The principle of the initial image processing module is shown in Fig. 3. The first mock exam module is to process the initial image data information generated in the previous module. The research uses K-means clustering algorithm and FCM two algorithm to realize the classification and partition of initial data, so as to provide basis for determining the pollution scope of offshore factory wastewater. The system setting module can adjust the detection device, cycle, time, weather sampling time and other parameters in the process of pollution monitoring.

4. Analysis effect of ERT pollution monitoring data

4.1. Analysis of ERT image processing effect

In this study, the ultraviolet image of wastewater pollution in coastal area is obtained by the marine wastewater monitoring data station. The data content of the image is interfered by 1% Gaussian noise. The gray image is obtained by preliminary processing of the image, as shown in Fig. 4.

The results of gray-scale image processing for different wastewater polluted sea areas are shown in Fig. 4, and the pollution degree of wastewater in the four regions is increasing. The pollution range of the area can be roughly estimated from the image, but due to the fuzzy edge area of wastewater pollution, it cannot be accurately evaluated. Therefore, the research uses the image segmentation algorithm to further process the grayscale image. The image segmentation algorithms used in the experiment include one-dimensional threshold image segmentation algorithm, two-dimensional threshold image segmentation algorithm and improved two-dimensional image threshold segmentation algorithm based on genetic algorithm. The population size and iteration times of genetic algorithm are set to be 40 and 100, respectively. The selection operator, crossover operator and mutation operator are roulette selection operator, two-point crossover operator and uniform mutation operator The crossover probability and mutation probability were set to 0.2 in Fig. 5.

Fig. 5 is the effect picture obtained by using different image segmentation algorithms to segment the gray image in Fig. 4. It can be seen from the figure that after the image segmentation algorithm processing, the range of the polluted area in the image is more obvious than that in the gray image, but the size and range of the polluted area obtained by different algorithms are different. The running time of the six algorithms for region 1 segmentation is 159, 162, 31,574, 34,327, 180, and 202 ms. It can be seen that the speed of one-dimensional OTUS algorithm is the fastest, and the processing speed of one-dimensional maximum entropy algorithm, GA + two-dimensional OTUS algorithm and GA + two-dimensional maximum entropy algorithm is slow, but the time difference between one-dimensional OTUS algorithm and one-dimensional OTUS algorithm is not significant. The processing speed of two-dimensional OTUS

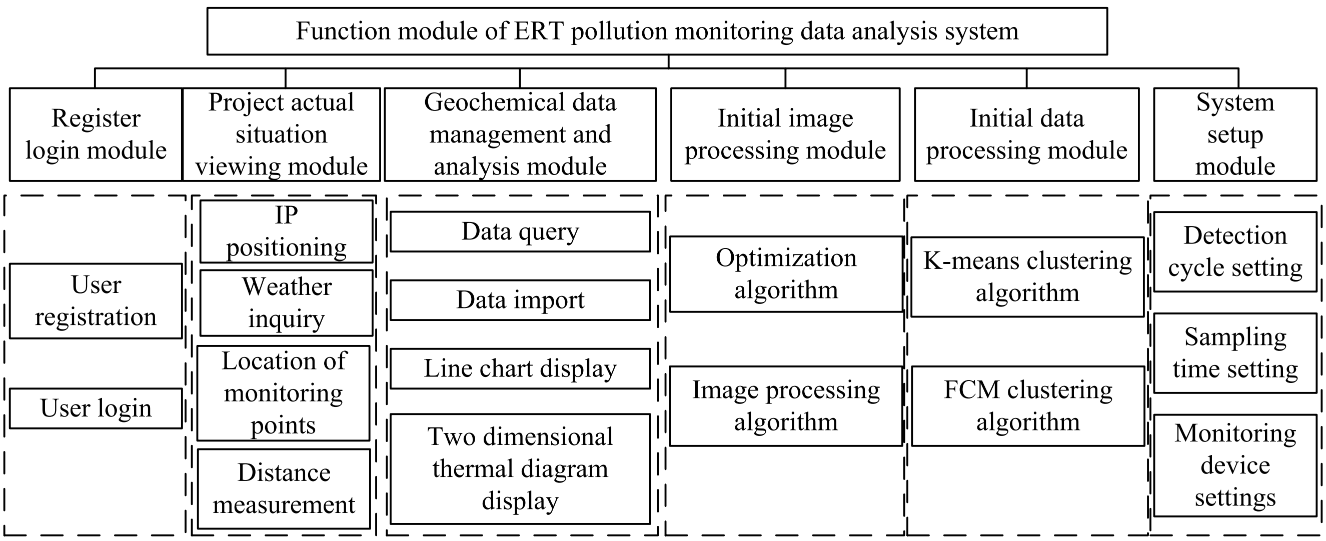

Fig. 3. ERT pollution monitoring data analysis system.

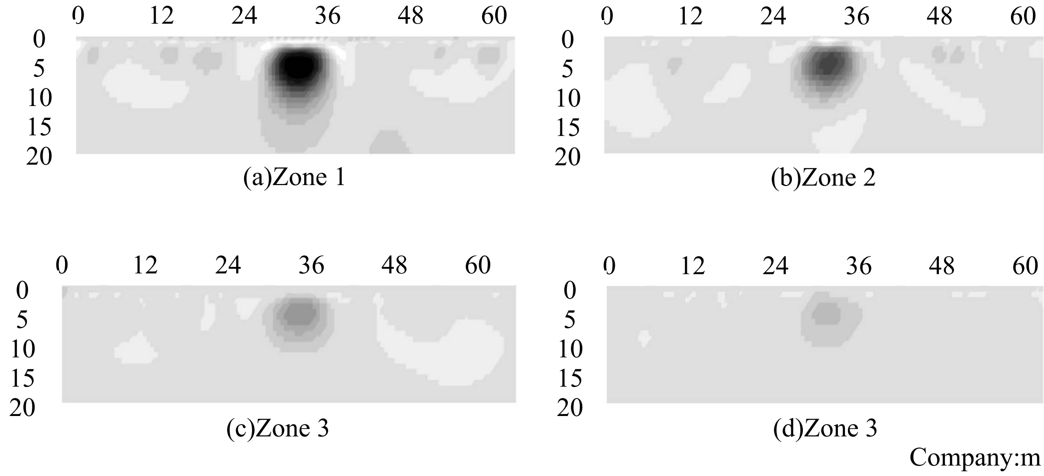

Fig. 4. UV image processing results in different areas.

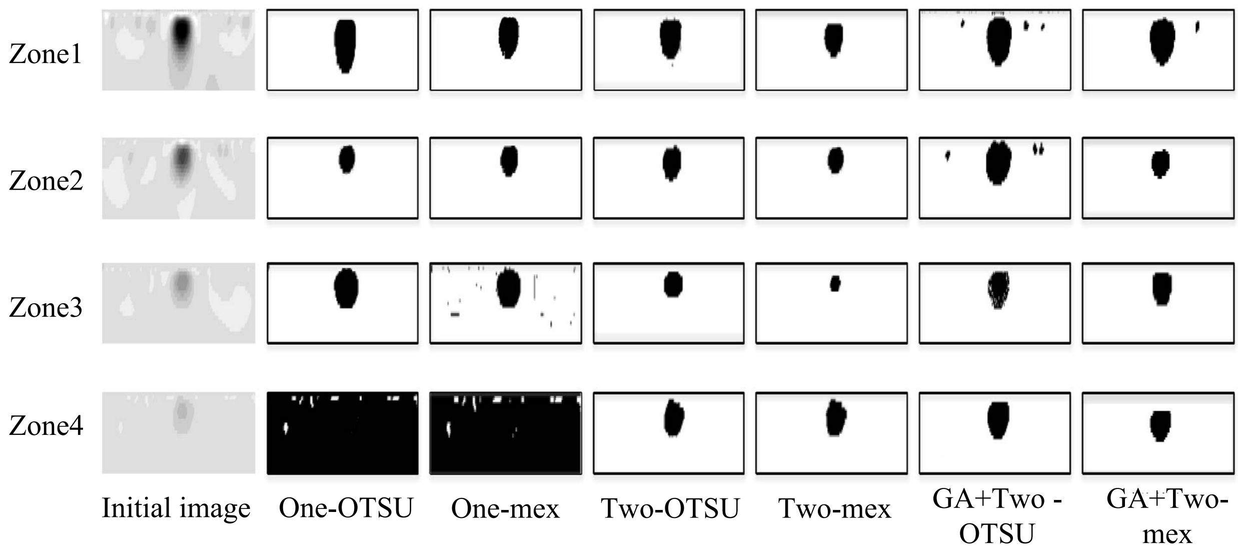

Fig. 5. Image segmentation results.

algorithm and two-dimensional maximum entropy algorithm is the slowest in Fig. 6.

After expert analysis, the centroid coordinates of area 1, 2, 3 and 4 with different pollution levels are (33 m, 4 m). The centroid deviation distance comparison results of the wastewater pollution image after segmentation are shown in Fig. 6. Centroid deviation is the Euclidean distance between the centroid position of image segmentation result and the standard centroid position of model. With the deepening of wastewater pollution, the distance of centroid deviation is also gradually reduced, which shows that when the pollution degree is higher and the pollution effect is more obvious, the segmentation effect of each image segmentation algorithm is also the best. The deviation distance of two-dimensional maximum entropy algorithm in processing region 1 image is the smallest, which is 0.72 M; GA + two-dimensional maximum entropy algorithm has the minimum deviation distance of 0.81 M when processing region 2; the minimum deviation distance of two-dimensional maximum entropy algorithm in processing region 3 image is 0.95 m; the deviation distance of two-dimensional maximum entropy algorithm in processing area 4 image is the smallest, which is 1.01 m. Secondly, the two-dimensional entropy GA algorithm is the best. However, due to the slow processing speed of two-dimensional maximum entropy algorithm, the comprehensive performance of GA + two-dimensional maximum entropy algorithm constructed in this study is the best.

4.2. Determination of wastewater pollution scope of offshore plants

In this study, K-means clustering algorithm and FCM clustering algorithm are used to extract the data of the wastewater pollution image after graying and threshold segmentation. The processing results are statistically analyzed by taking the average value through multiple processing. The intuitive results of the treatment are shown in Fig. 7.

When K-means clustering algorithm and FCM clustering algorithm are used for data extraction, the data in the image are divided into two types, black area represents wastewater polluted area, and white area represents unpolluted seawater area. The results of the two algorithms are shown in Fig. 7. The centroid position of the two algorithms is different, and the image after clustering processing shows that the polluted area is different from that after graying and segmentation. The image shows that the more serious the pollution, the wider the diffusion range of pollutants. The processing time of K-means clustering algorithm is 245, 232, 251, 245 ms for region 1, 2, 3 and 4 images, and 261 ms for FCM clustering algorithm. The processing speed of K-means clustering algorithm is slightly higher than that of FCM clustering algorithm, and the processing convergence speed is fast.

Table 1 shows the calculation results of clustering center position and centroid deviation distance of the effect image obtained by K-means clustering algorithm and FCM algorithm after processing different regions. As the pollution degree of wastewater is deeper and the range of pollution increases, the accuracy of image processing by clustering algorithm decreases. The centroid deviation distances of images in regions 1, 2, 3 and 4 processed by K-means clustering algorithm are 0.77 m, 1.33 m, 1.67 m and -. The centroid deviation distances of images in regions 1, 2, 3 and 4 processed by FCM clustering algorithm are 0.56 m, 0.80 m, 1.65 m and -. Compared with K-means clustering algorithm, FCM clustering algorithm has higher accuracy in image processing. When the two clustering algorithms are used to process the heavily polluted area 4 image, the specific cluster center point coordinates are not obtained.

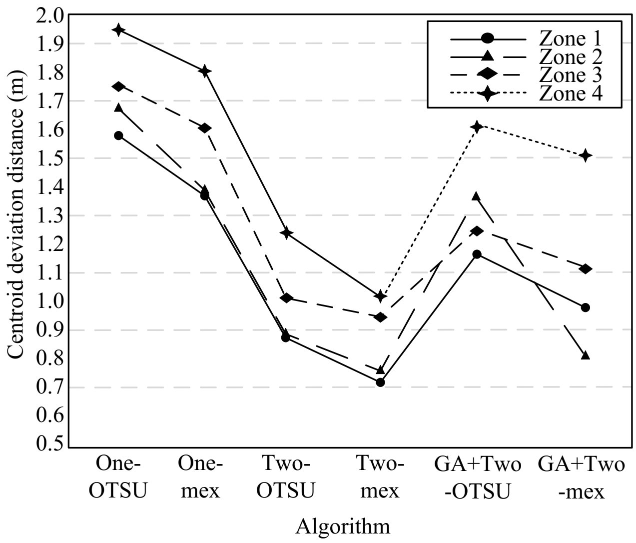

Fig. 6. Comparison of centroid deviation distance of different segmentation algorithms in wastewater pollution image processing.

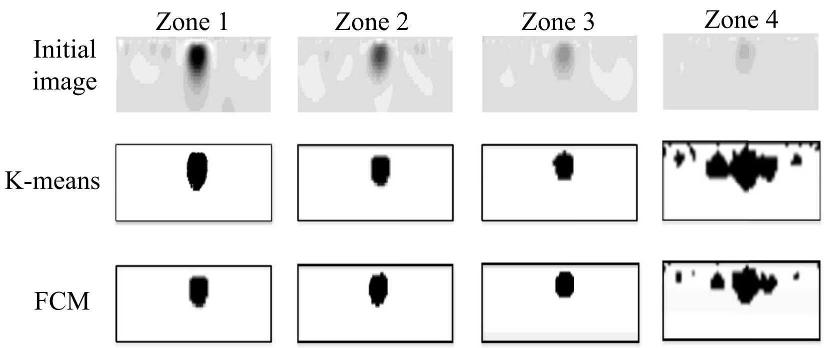

Fig. 7. Image data processing results of wastewater pollution.

Table 1
Centroid deviation distance comparison of wastewater treatment images

Processing area	Algorithm	Cluster center	Centroid position	Centroid deviation distance (m)	Contaminated area (m^2)
Zone 1	K-means	[97.52, 23.51]	(32.35, 4.41)	0.77	98.4
	FCM	[98.27, 20.36]	(33.07, 3.45)	0.56	94.2
Zone 2	K-means	[98.78, 45.33]	(34.18, 4.62)	1.33	111.6
	FCM	[99.96, 41.28]	(33.28, 3.24)	0.80	111.2
Zone 3	K-means	[100.58, 73.75]	(34.39, 4.92)	1.67	130.8
	FCM	[99.01, 69.53]	(31.65, 3.05)	1.65	129.5
Zone 4	K-means	[99.68, 90.42]	–	–	252.6
	FCM	[100.05, 85.53]	–	–	241.3

This is because in the seriously polluted sea area, the pollutant diffusion range is wider, but this situation does not affect the calculation of the polluted area. FCM clustering algorithm has higher accuracy, and the pollution areas of four regions are 94.2, 111.2, 129.5 and 241.3 m^2 respectively.

5. Conclusion

The definition of contract scope of environmental liability insurance in various countries is vague, and there are many disputes about the insurance nature and scope of progressive pollution insurance. In order to clarify the coverage of environmental liability insurance for wastewater discharge from offshore plants, an analysis system of progressive environmental liability insurance coverage was constructed in this study. The genetic algorithm is used to improve the two-dimensional OTUS algorithm. After the initial image of marine wastewater is processed, FCM algorithm and K-means algorithm are used for data analysis to obtain the specific range of marine wastewater pollution. The test results show that the proposed algorithm has smaller centroid deviation distance and faster running speed, which is better than conventional algorithms such as one-dimensional OTUS algorithm. Compared with the clustering analysis results of FCM algorithm and K-means algorithm, FCM clustering algorithm has higher accuracy in image processing. Finally, the system calculated that the area of wastewater pollution in area 1, 2, 3 and 4 were 94.2, 111.2, 129.5 and 241.3 m^2, respectively. The environmental liability insurance coverage analysis system constructed in this study has fast operation speed and high processing precision, which can be used to assist insurance companies to determine the coverage of environmental liability insurance for offshore plant wastewater discharge. But this research and after practical application, we need to improve the possible deficiencies through empirical analysis.

References

[1] A. Byrne, The 1979 convention on long-range transboundary air pollution: assessing its effectiveness as a multilateral environmental regime after 35 years, Trans. Environ. Law, 4 (2015) 37–67.

[2] M.N. Lang, A. Gohm, J.S. Wagner, The impact of embedded valleys on daytime pollution transport over a mountain range, Atmos. Chem. Phys., 15 (2015) 14315–14356, doi: 10.5194/acp-15-11981-2015.

[3] M. Singh, India proposes tighter water, air pollution standards for range of industries, Int. Environ. Report., 38 (2015) 1513–1513.

[4] F.M. Díaz-Méndez, A. Rodríguez-Ariza, J. Usero-García, C. Pueyo, J. López-Barea, Mutagenic activation of aromatic amines by molluscs as a biomarker of marine pollution, Environ. Mol. Mutagen., 31 (2015) 282–291.

[5] B.G. Kwon, K. Koizumi, S.-Y. Chung, Y. Kodera, J.-O. Kim, K. Saido, Global styrene oligomers monitoring as new chemical contamination from polystyrene plastic marine pollution, J. Hazard. Mater., 300 (2015) 359–367.

[6] A. Tonacci, G. Lacava, M.A. Lippa, L. Lupi, M. Cocco, C. Domenici, Electronic nose and AUV: a novel perspective in marine pollution monitoring, Mar. Technol. Soc. J., 49 (2015) 18–24.

[7] N. Sakthi Priya, M. Doble, J.S. Sangwai, Bioremediation of coastal and marine pollution due to crude oil using a microorganism bacillus subtilis, Procedia Eng., 116 (2015) 213–220.

[8] M.G.J.P. Tiquio, N. Marmier, P. Francour, Microplastics pollution in South China Sea and future prospects, Ocean Dev. Manage., 37 (2020) 40–47.

[9] Y.J. Huang, Marine pollution originating from purse seine and longline fishing vessel operations in the Western and Central Pacific Ocean, AMBIO, 46 (2017) 190–200.

[10] M. Seddighi, S.M. Hejazi, Water-oil separation performance of technical textiles used for marine pollution disasters, Mar. Pollut. Bull., 96 (2015) 286–293.

[11] J. Chen, Y. Wang, M. Song, R. Zhao, Analyzing the decoupling relationship between marine economic growth and marine pollution in China, Ocean Eng., 137 (2017) 1–12.

[12] B.A. Polidoro, M.T. Comeros-Raynal, T. Cahill, C. Clement, Land-based sources of marine pollution: pesticides, PAHs and phthalates in coastal stream water, and heavy metals in coastal stream sediments in American Samoa, Mar. Pollut. Bull., 116 (2017) 501–507.

[13] H. Xu, Y. Jiang, G. Xu, Insights into bioassessment of marine pollution using body-size distinctness of planktonic ciliates based on a modified trait hierarchy, Mar. Pollut. Bull., 107 (2016) 88–91.

[14] O.N. Lukyanova, E.V. Zhuravel, D.N. Chulchekov, A.A. Mazur, Sea urchin embryogenesis as bioindicators of marine pollution in impact areas of the sea of japan/east sea and the sea of Okhotsk, Arch. Environ. Contam. Toxicol., 73 (2017) 322–333.

[15] L. Yang, Y.X. Dong, D.Q. Huang, X.Q. Zhang, J.H. Du, Morphology and grain size of the near surface sediment over coastal sand sheet response to typhoon, Sci. Geogr. Sin., 37 (2017) 1243–1250.

[16] Y. Han, Q. Li, Detection method of Hg^{2+} impurity content in marine pollution based on intelligent image processing, J. Coastal Res., 97 (2019) 229–235.