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# *Remote Sensing and Geographic Information System Technology in Marine Resource Monitoring*

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***Abstract:*** Marine resources (MR) are an indispensable resource, but the pollution and shortage of MRs are becoming more and more serious, which will directly affect national life and economic construction. With the development of the Internet of Things at home and abroad, more and more Internet of Things technologies are applied in the field of MR monitoring, which greatly promotes the development of MR monitoring technology. The main purpose of this paper is to study the application of remote sensing (RS) technology and geographic information system (GIS) technology to the monitoring of MRs. In this paper, based on the correlation between the use of sea features and the types of sea use, the type of sea use mode is mainly considered when using RS images to monitor the types of typical sea features in the coastal zone. Experiments show that the location accuracy of the coastline extracted by the method in this paper can reach more than 87%, and the overall classification accuracy can reach more than 84%, which can meet the extraction and classification accuracy requirements of large-area coastlines. It provides an innovative architectural strategy for the automatic extraction and classification of coastlines, which greatly simplifies the parameter setting and attribute classification.

## 1. Introduction

In recent years, the types of data sources obtained from RS images have gradually increased, and the spatial resolution of the obtained images has been improving. Therefore, many scholars have begun to use high-resolution images to extract MRs. However, such methods are not suitable for large-area MR extraction, because MRs are widely distributed and high-resolution images are expensive to obtain. In contrast, medium-resolution RS imagery provides a cheaper acquisition method, has appropriate ground resolution, and covers a wide area, allowing large-scale and continuous mapping and monitoring [1-2].

In related research, Demir designed an energy-saving image recognition system for ocean monitoring [3]. A recognition framework is proposed that will adaptively adjust system parameters according to environmental conditions to optimize energy consumption while ensuring high recognition accuracy. The first part of the proposed decision system contains a convolutional neural network (CNN)-based animal recognition block for obtaining single-frame confidence. Saadi et al. combined RS, GISs, and ground surveys to study the flora composition of medicinal plants and herbs inside and outside the village of Chilkigal [4]; using the thematic function in ArcGIS software to create a GPS and GIS Land Use and Land Cover (LULC) layers and interpolated plant species locations. Implement relationships between land use and medicinal plant species to explore plants modeled on spatial and non-spatial data under a GIS platform.

At present, there have been a lot of achievements in the research on the continental coastline, but the monitoring of the coastline change is still relatively small. Quantifying the trend of coastline changes in different regions and evaluating coastline changes are of great significance for evaluating current and future ecological environment, economic and social impacts [5-6]. On the one hand, it can increase the attention of decision-makers and managers to the disaster risk caused by the change of coastline, and on the other hand, it can provide information and decision-making basis for the scientific planning and development of coastal zones in different regions. Since the use of RS means can only identify the characteristics of the sea surface, but cannot directly identify the use of the sea area, in order to determine the use of the sea area, it is mainly based on the method of inference, which is based on the correlation between the use of sea features and the type of sea use. Therefore, this paper mainly considers the type of sea use mode when monitoring the typical sea feature types in coastal zone by using RS images.

## 2. Design Research

### 2.1. There are Deficiencies

In recent years, with the large-scale advancement of human development of MRs and the development of marine industries, the negative impacts of seawater pollution, reduction of marine biological species, destruction of marine ecosystems, and development and utilization of MRs have become increasingly prominent. Under this situation, the research on marine ecological economy is gradually emerging [7-8]. However, the existing research still has some shortcomings, mainly as follows:

(1) Insufficient data

On the basis of summarizing domestic and foreign research results, this paper explores and establishes a relatively complete marine ecological economic accounting system that integrates MRs, marine environmental pollution costs and marine ecological value. However, due to incomplete statistical data and survey data, in In the process of accounting, there are still some data that are difficult to obtain and can only be replaced or estimated, resulting in a certain deviation between the accounting results and the objective reality.

(2) The technology is immature

In this paper, the detailed accounting of marine ecological economy is carried out, and its spatial evolution law is studied and judged, and the grid GIS technology is introduced into the exploration. There are still many areas worthy of discussion and improvement, which need to be further explored and studied in the future [9-10].

### 2.2. Overview of the Development of MRs Monitoring

(1) Manual monitoring

Manual monitoring is an early method of MR monitoring. Due to the limited monitoring equipment in the early manual monitoring, the types of marine MRs that can be manually monitored are also limited. With the advancement of technology, the types of MRs that can be monitored have expanded to flow, flow rate, water temperature, evaporation, water quality (comprehensive parameters), etc. In the early stage of development, these instruments can only display monitoring data in the form of a display screen or a dial, and do not have a data output interface, so that water conservancy workers can only collect monitoring data manually. For water quality monitoring, laboratory analysis methods are required. Although on-site monitoring can be achieved with the help of portable water quality analysis instruments, manual operations are still required. The manual monitoring method not only takes a lot of manpower and time, but also has low work efficiency, large labor volume, low monitoring frequency, limited monitoring range and poor timeliness [11-12].

(2) Remote monitoring of computer systems

With the rise of single-chip microcomputer and the development of intelligent instruments, a simple and decentralized computer monitoring system is formed. The structure diagram of the MRs online monitoring system is shown in Figure 1, which is usually used for a single monitoring station to realize short-distance automatic monitoring [13-14].

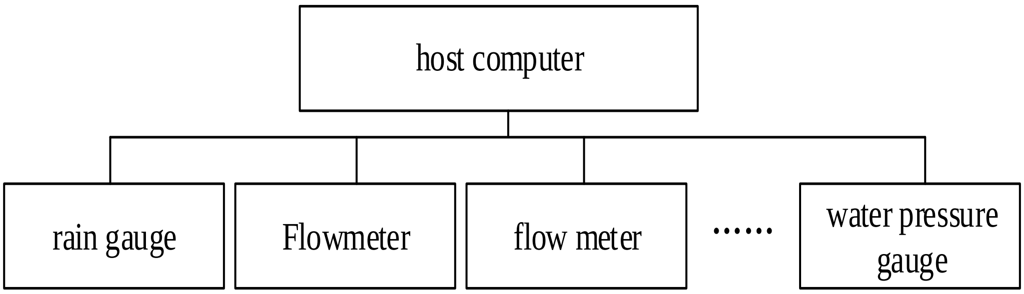


*Figure 1. Structure diagram of MRs online monitoring system*

With the application and popularization of the network, the monitoring computer of a single monitoring station can be connected to the network, and the monitoring data can be aggregated to the upper-level servers at different levels, thus forming a large-scale computer system monitoring network [15-16]. The use of the upper-level server has an overall perspective on monitoring activities in different regions, making it possible to cooperate and assist between monitoring stations, and high-level users also have a good platform for use, which can form a large-scale monitoring network with local monitoring and central management and control. However, this monitoring method not only requires the use of a large number of monitoring computers, resulting in waste of resources and high cost, but also requires an industrial control bus between the monitoring computer and the smart instrument, which is not conducive to the expansion and deployment of the system.

(3) Remote monitoring based on DTU

With the development and popularization of wireless communication technology, DTU (Data Transfer Unit) has been developed and applied in MR monitoring. By using DTU, MR information can be reported to the remote monitoring center in wired (Ethernet, PSTN, ADSL, etc.) or wireless (ultra-short wave, satellite, GSM, GPRS, etc.) methods to form a large-scale monitoring network. DTU usually uses a single-chip microcomputer as a controller, connects with single or multiple monitoring instruments through hardware wiring, and uses a network communication module to transmit data. Because the GPRS network has the advantages of fast access, high transmission rate, high transmission efficiency, wide coverage, and permanent online, this type of monitoring method usually uses GPRS technology to realize wireless data transmission. A GPRS-based MR quality monitoring scheme is shown in Figure 2.

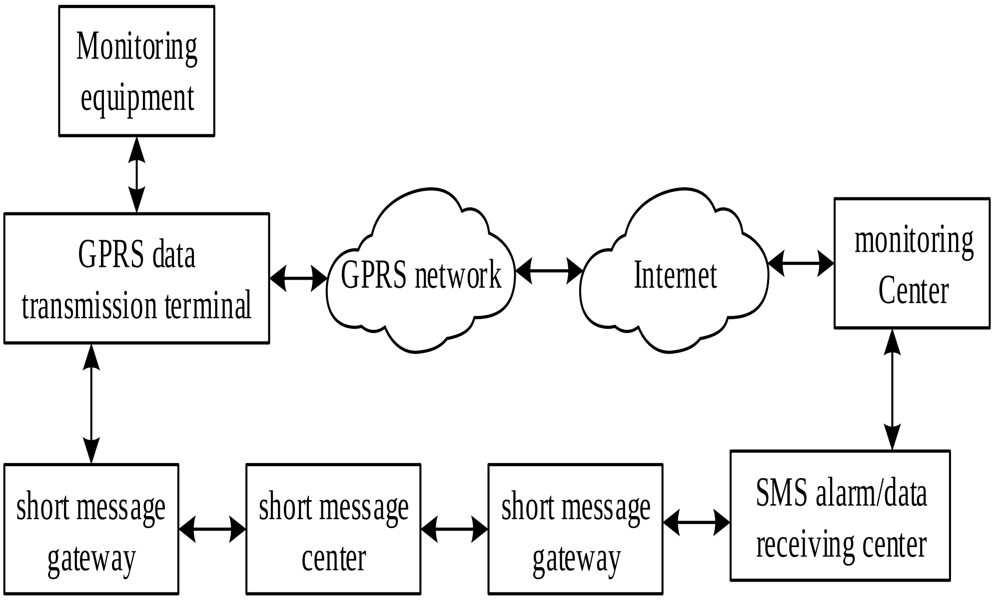


*Figure 2. A GPRS-based MR quality monitoring scheme*

This monitoring method based on data transmission units and smart meters can overcome the monitoring difficulties caused by geographical reasons and realize real-time online automatic monitoring of MRs, so it is widely used. Compared with remote monitoring of computer systems, it can save resources and facilitate system deployment and expansion. But in this monitoring method, the data transmission unit is not only a single point of failure, but its function largely determines the performance of the MR monitoring system. At present, there are many kinds of data transmission units on the market, but the mutual compatibility is poor, which is not conducive to the formation of a unified monitoring platform [17-18].

(4) Remote monitoring based on the Internet of Things

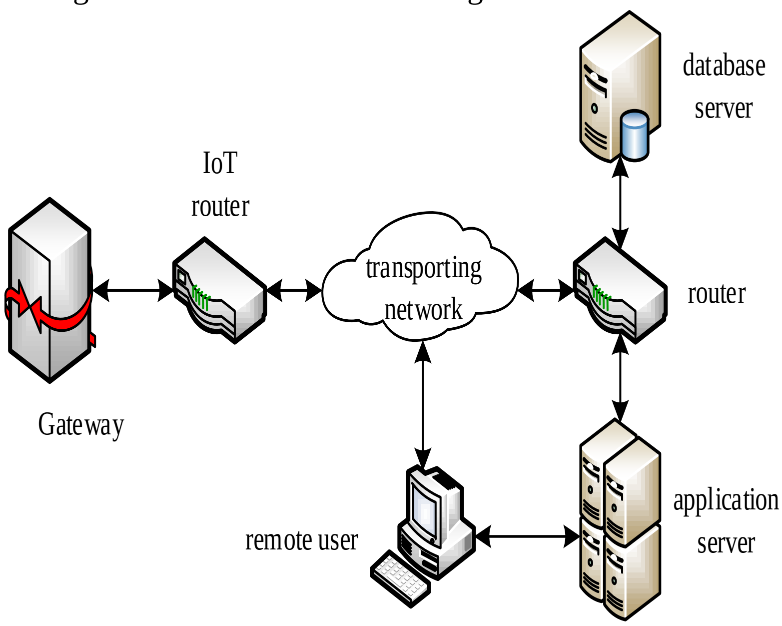


*Figure 3. Architecture diagram of a marine monitoring system based on the Internet of Things*

This monitoring method not only has the advantages of the DTU-based remote monitoring method, but also combines the MR data acquisition equipment and transmission equipment into a single sensing node, and the sensing nodes can exchange information in the private wireless communication network, reducing the communication cost. It gets rid of the dependence of DTU and monitoring instruments on hardware connection in DTU monitoring mode, which is convenient for the deployment and maintenance of sensing nodes. However, sensing nodes usually require customized hardware units and software systems, and generally cannot directly use mature smart meters, resulting in high development costs.

### 2.3. Canny Edge Detection Linear Target Extraction

The Canny edge extraction algorithm is used to extract the edge of MRs, and its value is recorded as a two-dimensional grid matrix, indicating that the value of the edge is 1, and the value of the background is 0. Specific steps are as follows:

In order to avoid noise affecting the accuracy of edge detection, this chapter can use a Gaussian filter to smooth the image, and use a convolution Gaussian filter kernel with a size of (2k+1)×(2k+1), and the generation equation is as formula (1) shown.

$$H_{ij} = \frac{1}{2\pi\sigma^2}\exp(-\frac{(i-(k+1))^2+(j-(k+1))^2}{2\sigma^2});1 \le i, j \le (2k+1) \tag{1}$$

In the formula, σ is the variance, and k is the dimension of the determined kernel matrix.

After image smoothing, a part of the noise is eliminated. However, due to the multi-direction, it is also necessary to detect the horizontal, vertical and diagonal edge directions in the image. Use the first derivative value to determine the direction and gradient of the pixel, as shown in the following equations (2) and (3).

$$G = \sqrt{G_x^2 + G_y^2} \tag{2}$$

$$\theta = \arctan(\frac{G_y}{G_x}) \tag{3}$$

In the formula, G is the gradient strength, and arctan is the arc tangent function.

At present, the Canny edge detection algorithm is widely used in road edges, medical images, etc. However, because the MRs are in the seawater background with complex spectral characteristics, the research on the application of the Canny edge detection algorithm in this area is still relatively scarce. Therefore, this chapter By introducing spatial feature-edge information, on the basis of obtaining NDVI visual saliency features, we compared the extraction effect in the case of complex MR background.

## 3. Experimental Study

### 3.1. Overall Structure of the Platform

The network topology of seawater resources monitoring is analyzed and designed, the platform is displayed from the perspective of physical composition, and the overall structure of the platform is designed on this basis. The platform adopts the common three-layer structure of the Internet of Things, that is, the realization layer, the network layer and the application layer. The corresponding relationship between the strategic structure of the platform and the topological structure of the MRs monitoring network is shown in Figure 4.

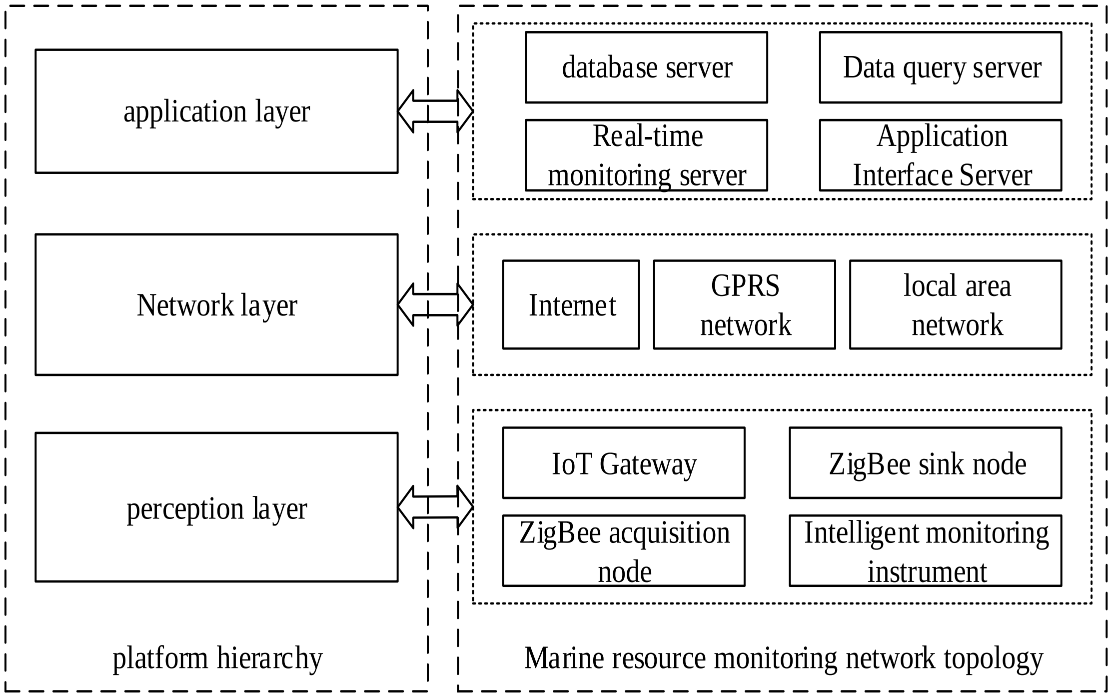


*Figure 4. The corresponding relationship between the platform hierarchy and the MR monitoring network topology*

### 3.2. Specific Steps

(1) Classifier parameter settings

Support vector machine (SVM) is proposed from the optimal classification surface under the condition of linear separability. The objective function can be obtained by formula (2.1)

$$\min \frac{1}{2}\|W\|^2 + C\sum_{i=1}^{n}\varepsilon_i \tag{4}$$

In the formula, ε=(ε1,ε2,⋯,εn) is the set of slack variables introduced; C is the penalty parameter.

In the above formula, the selection of the C value has a greater impact on the experimental results. When a larger C value is selected, the allowable total error misclassification degree is lower, and the classification accuracy is higher. Relatively speaking, when the C value is small Classification accuracy is low. However, if the value of C is too large, the experimental results will be over-fitted, but if the value of C is too small, the accuracy of the model will be too low. Therefore, the influence of C value on the accuracy of classification results cannot be ignored.

(2) Accuracy evaluation

In the precision verification, the recall rate, accuracy and F mean are used to evaluate the quality of the two methods. The specific calculation formula is as follows (5-7),

$$\mathrm{Precision} = \frac{TP}{TP+FP} \tag{5}$$

$$\mathrm{Recall} = \frac{TP}{TP+FN} \tag{6}$$

$$F - Measure = \frac{2 \times \mathrm{Re}\,call \times \mathrm{Pr}\,ecision}{\mathrm{Re}\,call + \mathrm{Pr}\,ecision} \tag{7}$$

In the formula, TP is the correct value, FP is the wrongly mentioned value, FN is the missing value, and F-Measure is the combination of recall and recall.

In theory, better results should have higher recall rate and accuracy, but in practice recall rate and accuracy are often conflicting, so F-Measure is used to comprehensively evaluate the quality of the experimental results.

On this basis, the accuracy of coastline classification is evaluated. First, assign the type of the sample points whose random points fall within one pixel in the previous step, then use the spatial connection tool of ArcGIS 10.3 to establish attribute connections between the sample points and the coastline, and finally calculate the accuracy of the coastline classification results, and its evaluation indicators include the overall accuracy (OA) and kappa coefficients. The calculation formula of each index is shown in formula (8) and formula (9).

$$OA = \frac{\sum_{i=1}^{r} x_{ii}}{n} \times 100 \tag{8}$$

$$Kappa = \frac{n\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r}(x_{i+} \cdot x_{+i})}{n^2 - \sum_{i=1}^{r}(x_{i+} \cdot x_{+i})} \tag{9}$$

where n represents the total number of pixels, r represents the number of types, xii is the number of correctly classified pixels, and x+i and xi+ represent the sum of each row and column in the confusion matrix, respectively.

## 4. Experiment Analysis

### 4.1. Statistics of MRs

This paper summarizes the global aquatic product capture and aquaculture statistics in the past six years, as shown in the following table:

*Table 1. Statistics of global aquatic product capture and aquaculture in the past six years*

| Years | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Fishing activity (million tonnes) | | | | | | |
| Inland | 10.7 | 11.2 | 11.2 | 11.3 | 11.4 | 11.6 |
| Ocean | 81.5 | 78.4 | 79.4 | 79.9 | 81.2 | 79.3 |
| Total catch | 92.2 | 89.5 | 90.6 | 91.2 | 92.7 | 90.9 |
| Aquaculture (million tons) | | | | | | |
| Inland | 38.6 | 42.0 | 44.8 | 46.9 | 48.6 | 51.4 |
| Ocean | 23.2 | 24.4 | 25.4 | 26.8 | 27.5 | 28.7 |
| Total aquaculture | 61.8 | 66.4 | 70.2 | 73.7 | 76.1 | 80.0 |
| Total world fisheries and aquaculture | 154.0 | 156.0 | 160.7 | 164.9 | 168.7 | 170.9 |

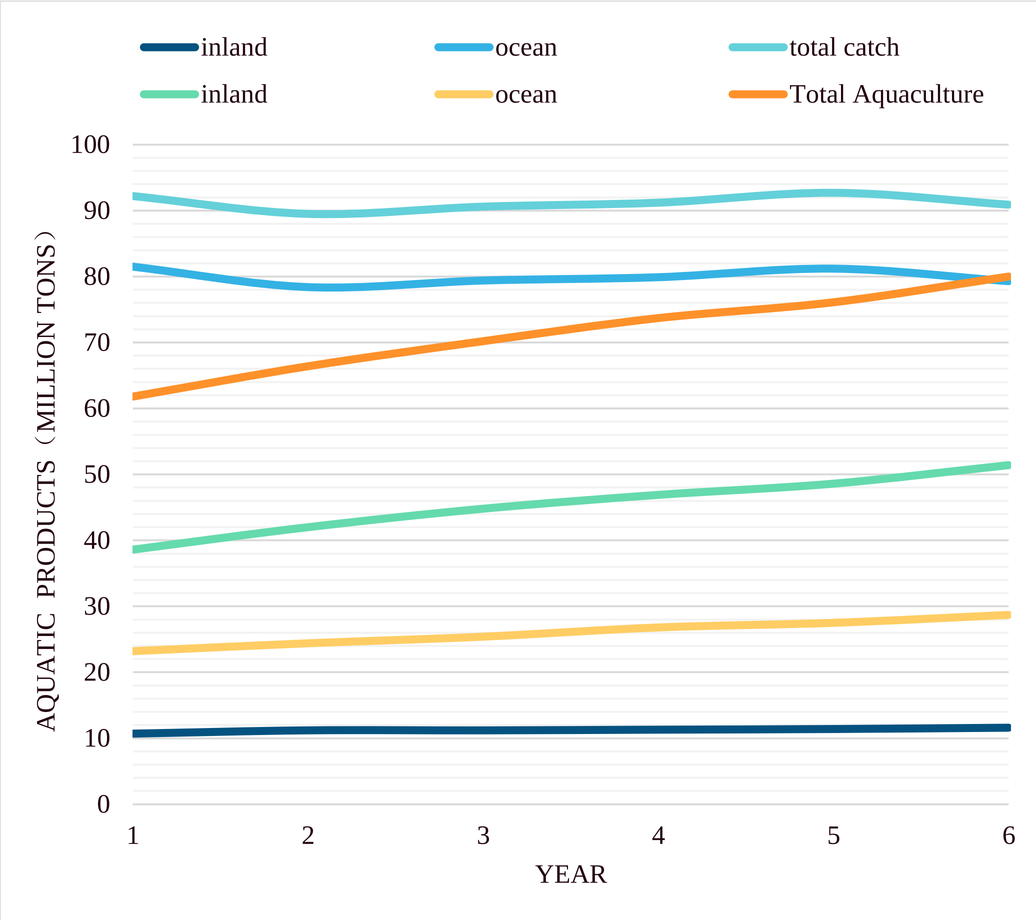


*Figure 5. Analysis of global aquatic product capture and aquaculture statistics in the past six years*

As can be seen from the above chart, the total world fishery production in the sixth year was 90.9 million tons, slightly lower than the previous two years. Among them, marine and inland fisheries account for 87.2% and 12.8% of global fisheries, respectively, while the total global aquaculture (aquatic plants) production is 110.2 million tons, with an estimated initial sales of 243.5 billion US dollars.

## 4.2. The Overall Trend of Fishery Resources

Fishery production has begun to recover, but it is the middle and pelagic species that drive the increase, especially the low-trophic aquatic products. At the same time, in contrast to the increase in total fishery output, the catch yield per unit of fishing effort (CPUE) is decreasing year by year, as shown in the following table:

*Table 2. Exploitation of marine organisms in the world's major economies (%)*

| Development type | Low/moderate development | Fully developed | Over developed | Severe recession |
|---|---|---|---|---|
| Development degree | 25% | 47% | 18% | 10% |

At present, fishery resources are declining all over the world. At present, among the more than 400 major marine economic species in the world, only 1/4 is in the state of medium and low development, nearly 1/2 is in the state of full development, nearly 1/5 is in the state of excessive development, and 1/10 of the species have appeared. Signs of severe recessions, 80% of which are irreversible. Fishery resources generally show a declining trend. This shows that the population density of fishery resources is decreasing year by year.

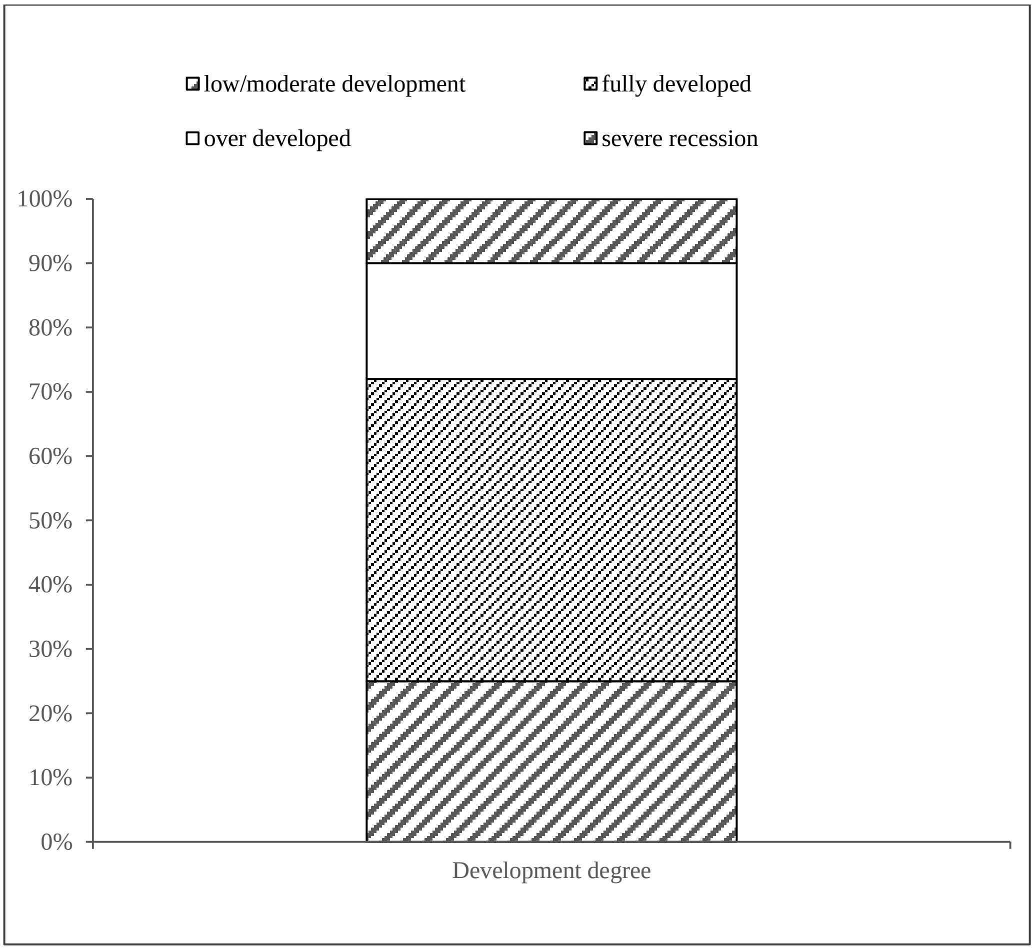


*Figure 6. Analysis of the degree of marine biological development in the world's major economies*

### 4.3. Experimental Results and Analysis

First, the value of the slack variable r is fixed at 0.5, and the value of the penalty parameter C is 10, and then compared with the C value results of 100, 200, and 300, respectively, to obtain the classification result with the best accuracy. The results show (Table 3),

*Table 3. Evaluation of coastline classification accuracy with different parameter settings*

| Parameter settings | oa | Kappa |
|---|---|---|
| C=10 | 79.33% | 70.43% |
| C=100 | 80.67% | 72.30% |
| C=200 | 84.50% | 77.97% |
| C=300 | 79.50% | 70.63% |

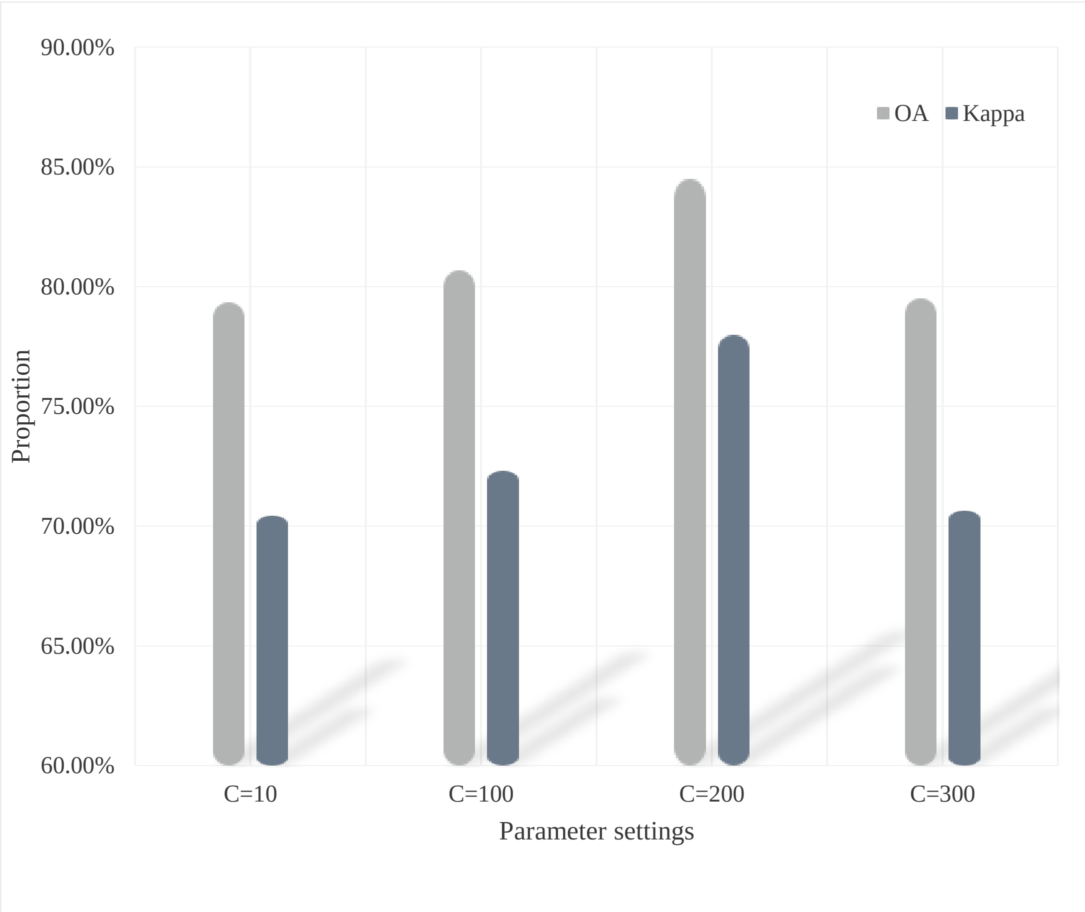


*Figure 7. Analysis of coastline classification accuracy evaluation with different parameter settings*

Analysis of the above figure shows that when the value of C parameter is between 10 and 200, the classification accuracy of the classifier improves slowly. When the value of C is too large, it will cause overfitting and reduce the classification accuracy. The location accuracy of the coastline extracted by the method in this paper can reach more than 87%, and the overall classification accuracy can reach more than 84%, which can meet the extraction and classification accuracy requirements of large-scale coastlines. It provides an innovative architecture strategy for the automatic extraction and classification of coastlines, which greatly simplifies the parameter settings and attribute classification, which is beneficial to the operation of the interpreter, and the extraction and classification efficiency of coastlines in large areas is fast and has a relatively high efficiency. Strong robustness.

## 5. Conclusion

The monitoring and management of Haitian objects in coastal areas requires a series of past, present and future observations to accurately adapt to diverse and dynamic environments. However, coastal areas are often large in scope and wide in coverage, and it is difficult for traditional manual survey methods to obtain basic data (including quantity, area, time and space distribution, etc.) It has the characteristics of wide range, strong timeliness, and free data acquisition, which can provide effective information to map the temporal and spatial distribution characteristics of typical sea features in coastal zones, which is important for the rational development and protection of coastal zones, ecological environment changes, regional economic development and coastal climate change research. significant. The application of RS and GIS technology in the field of MRs monitoring can not only improve the technical level and monitoring quality of MRs monitoring, better promote the construction of water conservancy informatization, but also expand the application scope of RS and GIS technology, promote RS And the application of GIS technology lays the foundation for the construction of the project.

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## Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

## Conflict of Interest

The author states that this article has no conflict of interest.

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