Research on Marine Disaster Prevention and Mitigation Information Platform System Based on Big Data

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Abstract. Affected by human activities, marine pollution is becoming more and more serious. Our coastal zone, estuary and bay ecosystems have been damaged to varying degrees. The application of marine ecological environment monitoring sensors can realize real-time monitoring and rapid early warning of the marine environment, which is of great significance for preventing marine disasters and regulating the contradiction between the development of the marine economy and the environment. Based on this research background, the thesis used TERRA/AQUA-MODIS, SARCOSMO-1/COSMO-2 and HY-1B satellite, aviation, ship, shore-based and other multi-source, multi-temporal monitoring data to build a centralized marine environment monitoring and information extraction The integrated business system integrated with functions such as integration, data collection, forecasting and early warning, and product release provides timely information on the ecological environment to the government and relevant departments during the emergency period, providing vigorous technology for disaster prevention and mitigation of the government and relevant departments The guidance provided a basis for starting the emergency plan in time.

Keywords: Big data, Marine disaster prevention, Disaster prevention information platform.

1. Introduction
The marine ecological environment plays an important role in global climate change. However, affected by human activities, the marine ecological environment is getting worse. In China, with industrial development and modernization, marine pollution, especially offshore pollution, is becoming more and more serious. Inshore seawater is generally polluted by inorganic nitrogen, activated phosphate, oil and heavy metals. Coastal zones, estuaries and bay ecosystems are all affected. In view of the different levels of damage, the sudden increase of marine pollution disasters such as red tides have become normalized year by year. Protecting and improving the marine ecological environment is already a strategic issue related to China's sustainable development.

At present, the more commonly used concept of marine ecological environment safety is: marine ecological environment safety can be regarded as the marine ecological environment and marine resources related to human survival, life and production activities in good condition or not subject to irreversible damage. The marine eco-environmental safety mentioned in this research refers to the
state where public health, production and life, and the development of the marine economy are not threatened by environmental pollution and ecological damage [1].

2. Current situation and development trend of China's marine environmental risks

2.1. Ocean spill
With the rapid growth of demand for petroleum resources, the scale of China's strategic oil reserves, offshore oil transportation and offshore oil development has rapidly increased, major offshore oil spill accidents have risen significantly, and the risk of oil spills has increased. According to statistics, from 1973 to 2006, China experienced two major ship oil spill accidents each year, with an average oil spill of 537 tons; from 2000 to 2005, the incidence of marine oil spills in China was significantly higher than the average of 1973-2006. Marine oil spill accidents mainly occur in oil terminals, unloading ports, sea areas near islands and sea oil and gas development areas. In recent years, the number of heavy oil spills on the sea has increased. Since 2010, major marine oil spills such as Dalian "7.16" and Bohai "19-3" oil wells have occurred, which have had serious impacts on the marine ecological environment.

2.2. Red tide and green tide
The occurrence of large-scale red tides in offshore China has increased, and the incidence of toxic and harmful red tides has increased. Ocean red tides are mostly concentrated in the coastal areas of Zhejiang, Shanghai, and Jiangsu. From 1972 to 2007, a total of 85 severe red tides occurred, and as many as 36 major red tides occurred from 2008 to 2009. The annual incidence of large-scale red tides is 5.14 times that of the past 25 years. In recent years, among the red tide disasters with an area of more than 1km², the dominant red tide species accounted for about 30% of the total. According to incomplete statistics, there have been more than 160 shellfish poisoning incidents in coastal areas, with more than 10,000 poisonings and nearly 60 deaths. In 2008, a large-scale green tide disaster broke out in the coastal waters of Qingdao for the first time, with a cumulative direct economic loss of more than 2 billion yuan [2].

2.3. Sea level rise
Affected by the global sea level rise, the rate of sea level rise in China has accelerated in the past 30 years, with an average rate of 2.5mm/a, which is generally higher than the global average rate of sea level rise. It is predicted that the sea level of China's offshore waters in 2039 will rise from 70 to 150 mm compared with the 2009 value. Among them, the highest value of sea level rise in Tianjin, Shandong, Shanghai, Guangdong and Zhejiang exceeds 140mm. At the same time, the compaction effect caused by the further expansion of near-shore cities and excessive groundwater extraction will inevitably aggravate the trend of sea level rise.

3. Trends of pollution degree in China's offshore waters
Since 2013, China’s total offshore polluted sea area (referring to the sea area that does not meet the clean sea water quality standards) and the lightly polluted sea area (referring to the national sea water quality standards of the third category sea water quality sea area) have basically the same trend. There has been a gradual decrease since 2016, which shows that, overall, light pollution in China's coastal waters has accounted for a large proportion in recent years. The area changes of several other types of sea areas with different water quality levels are quite different. Among them, the area of cleaner sea areas (referring to the second type of sea water quality in the national sea water quality standards) decreased first (2013-2017) and then increased (2018- ) the trend of change; while the area of moderately polluted sea areas (referring to the fourth category of sea water quality standards in the national sea water quality standards) has been relatively stable in recent years except in 2014; In 2014, there was a slight decrease in fluctuations (Figure 1).
4. Sensor-based marine disaster prevention and mitigation technology

4.1. Nutrient sensor

The development of nutrient sensors abroad is relatively mature. A number of instruments based on spectrometry such as Micro-LAB and EcoLAB2 from WET Labs of the United States and SUNAV2 from Satanic of Canada have already formed products. Although the stability is slightly lacking, the technology is relatively mature. In addition, nutrient sensors based on electrochemical methods have also developed significantly in recent years. China has also developed a prototype of a nutrient salt sensor project to achieve the detection of a variety of nutrients [3].

4.2. Heavy metal element sensor

Heavy metal in-situ sensors are mainly based on electrochemical techniques such as anode stripping voltammetry. This kind of sensor technology is relatively mature abroad. Representative is the Italian "VIP" heavy metal monitoring system. "VIP" is an in-situ heavy metal sensor using voltammetry, which can maintain good sensitivity at a water depth of 500 m. Another commercial instrument is the British Metalliser HM1000 heavy metal monitoring equipment, which uses the principle of anode stripping voltammetry to achieve portable online monitoring, which can measure ppb concentration of arsenic, cadmium, copper, lead and mercury. The metal element automatic analyser of Sichuan University introduces automatic reference and online concentration technology, and has many functions such as flow injection, online concentration and low-pressure ion chromatography. Zhejiang University has developed an automatic heavy metal analyser using electrochemical stripping voltammetry, which enables simultaneous determination of multiple elements.

4.3. Marine carbonate system sensors

pH, dissolved inorganic carbon (DIC), alkalinity (TA) and carbon dioxide partial pressure (pCO2) are the four parameters of the carbonate system, as shown in Figure 2 is the principle of marine carbonate detection sensor. The study of ocean acidification and carbon cycle has put forward higher requirements for the measurement accuracy of carbonate system sensors. Among the 4 parameters, the conventional sensors that can be used for in-situ monitoring are only pCO2 and pH sensors. The Seufert seawater pH sensor developed in recent years uses ion-sensitive field effect transistor technology to largely overcome the shortcomings of ordinary pH electrodes, and its measurement accuracy can reach 0.005. The method that can measure the pH of seawater most accurately is the photometric method. The in-situ seawater pH sensors with a measurement accuracy of up to 0.001 are currently only available in the United States based on the photometric method and the Spanish SP101-SM sensor. At the same time, because the photometric method can achieve "correction-free", the development of the other three parameter sensors based on the photometric method has also made.
great progress. Domestic Xiamen University has developed a prototype of a multi-channel seawater carbonate system based on photometry [4].

Figure 2. Principle of marine carbonate detection sensor.

5. Design of ocean disaster reduction and prevention platform under big data

5.1. Habitat quality evaluation method

Habitat quality indicators include three indicators: water environment, sedimentary environment and biological quality. The calculation formula is as follows:

\[ HQI_j = WQI_j + SQI_j + BQI_j \]  

In the formula, \( HQI_j \) represents the comprehensive index of marine habitat quality at station j, with a value range of 0-100, \( WQI_j \), \( SQI_j \), and \( BQI_j \) are the comprehensive evaluation of the water quality index, comprehensive sediment quality index, and biological quality comprehensive index at station j, respectively. The index weights of water quality, sediment and biological quality are 25%, 25% and 50%, respectively. The evaluation standards and weights of the indicators are recommended values, which can be determined by expert judgment or analytic hierarchy process according to the actual situation of the evaluated sea area.

The assessment of water environment quality, sedimentary environment quality and biological quality is based on the different use functions and protection goals of the intensive sea area, and based on the seawater quality, marine sediment quality and marine life quality standards, the "composite index" based on the single-factor index evaluation Method". For example, the water quality comprehensive index (WQI) is calculated according to equations (2) and (3)

\[ WQI_j = \frac{1}{n} \sum_{i=1}^{n} I_j \]  

\[ I_j = \frac{C_j}{S_j} \]  

Where \( WQI_j \) is the comprehensive index of water quality at station j; \( I_j \) is the single-factor environmental quality index of the i factor at station j; \( C_j \) is the measured concentration value (mg/L) of factor i at station j; \( S_j \) is the factor i The limit value of the environmental quality standard (mg/L); n is the number of all participating water quality items [5].
5.2. Overall design
The marine ecological environment monitoring system designed and developed by this project is mainly composed of seawater collection and distribution subsystem, monitoring sensor subsystem, data collection hardware subsystem and host computer software subsystem. The system integrates temperature, salinity, depth, turbidity, dissolved oxygen, chlorophyll, pH, total organic carbon, silicate, ammonia nitrogen, nitrite, nitrate, phosphate and other seawater quality monitoring parameters with high reliability, simple operation and low maintenance frequency. The overall structure of the system is shown in Figure 3.

![Figure 3. Marine ecological environment monitoring system.](image)

5.3. Software Design of System Host Computer
The host computer software is the intelligent core of the real-time monitoring system for the marine environment. MCGS based on the Windows system is used as the development platform. MCGS can solve the data in various ways through animation display, process control, alarm processing, report output, etc. Actual engineering problems are widely used in the field of automation and control. The software of the host computer of the system adopts multi-thread technology, and the multi-layer architecture and functional modular design can realize the operation control of the subsystems, the interactive communication between the subsystems, data collection, analysis and processing, data graphical display, and database storage and historical data call, external data communication and other functions. The system software structure design is shown in Figure 4.

![Figure 4. Software design structure diagram of real-time monitoring system of marine ecological environment.](image)

5.4. Verification of experimental results
The system is installed in a marine monitoring station. During the trial operation, the system runs continuously for 24 hours a day, and conducts on-site comparison monitoring experiments with a period of 6-9 days once a month. Seawater in the same area is tested using system testing and
laboratory standard methods, and the testing data for each parameter is obtained. Figure 5 shows the comparison experiment results of salinity, dissolved oxygen and silicate in nutrients in comprehensive parameters of water quality. Comparison results show that the system software can accurately display, store and transmit various marine ecological environment parameters in real time, has good operating stability and data accuracy, low failure rate, simple and convenient maintenance, and can be well applied to the ocean Ecological environment monitoring field [6].

Figure 5. Salinity comparison monitoring experiment results.

6. Conclusion
The marine ecological environment monitoring system designed in this paper adopts MCGS configuration development software, which has the advantages of stable and flexible data structure, good versatility, portability and scalability, vivid and clear interface, and simple user operation. The software data collection and control are flexible and can be set according to the actual needs of different users. The data storage and transmission efficiency are high, which can realize the efficient storage of real-time data and the network transmission of daily data. At the same time, the system also has some shortcomings, such as the software operation interface is not beautiful enough, the process abnormal interrupt processing and interrupt recovery processing are not comprehensive and perfect. Therefore, while ensuring and improving the stability of the system, it will gradually improve the existing deficiencies of the system, improve performance, and enable the system to better apply and serve the real-time monitoring field of the marine ecological environment.

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