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Regional Difference Assessment of Comprehensive Benefit of Marine Resources Development and Utilization Based on Web GIS Technology

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Abstract: As the most cutting-edge technology of GIS in recent years, Web GIS (WG) can collect, store, process, analyze and visualize heterogeneous, multi-source, and massive spatial geographic data. Therefore, the introduction of WG technology into MIM to build an information system for massive, multi-source, and heterogeneous MIM can improve the management efficiency of marine resources (MR) for the government and enterprises, and realize the precision, precision, and management of MR. Scientific planning and management are of great significance. The main purpose of this paper is to study the development and utilization of MR based on WG technology. This paper focuses on the analysis of the comprehensive benefits (CB) of marine resource utilization and the evaluation of differences in different regions. This paper analyzes the evaluation principles, and uses the corresponding calculation to compare the different benefits of different regions in my country. The final experiment shows that the CB index of MR is 1.89, 1.68, 1.56 in the high-level area of CB of MR. These areas have large MR, and they are at the forefront of the country in terms of marine aquaculture output value and marine fishing output value per capita marine fishery production value, and the income level of fishermen is also relatively high. The development of MR is a new profitable situation, and the fishery ecological environment has gradually improved. MR The overall level of CBs is high.

1. Introduction

The ocean is an important part of the global ecosystem, providing abundant natural resources and vast space resources for the sustainable development of human beings. With the scarcity of land resources, the deterioration of the environment and the in-depth reform of the economy, the ocean has increasingly become a medium for the development of the modern world. Research on the differential evaluation of marine ecological resources development and utilization and its improvement strategies is of great significance for enriching the theory of marine ecological culture construction and promoting the practice of marine ecological culture construction [1-2].

In a related study, Mishra et al. mentioned that geographic information systems (GIS) have been widely used as tools for spatial data manipulation, analysis, and dissemination of spatial/non-spatial results in a standardized format [3]. Therefore, the design and implementation of the water level space database derived from regular satellite altimetry of water bodies are introduced. A fully automated processing chain was developed, including download of satellite data, extraction of water levels using the developed model, database insertion and publishing of layers and charts. Web-GIS provides user-friendly GIS operations for visualizing thematic maps, as well as reporting services for selecting, displaying and downloading reports of water level data for selected water bodies. Stefanov proposed an open-source WG application for optimized visualization of meteorological data [4]. The app visualizes real-time data from private weather stations and open data sources. The application visualizes real-time data captured by weather stations and stored in an SQL database. The architecture of the open source WG application and its software implementation are also introduced. The applications presented were developed using open source software and tools.

Based on WG technology, this paper studies the development and utilization of MR. This paper focuses on the analysis of the CBs of marine resource utilization and the evaluation of differences in different regions. This paper firstly introduces the function and structure of GIS, analyzes the system architecture of WG, analyzes the shortcomings of traditional GIS applications and the characteristics of ocean visualization of WG technology; Compare the benefits of different regions.

2. Design Research

2.1. The Composition and Function of GIS

A GIS system is similar to an ordinary information system, usually composed of computer hardware system, computer software system, system management operators and geospatial data, as shown in Figure 1. These components cooperate with each other to complete the storage, calculation and analysis tasks of GIS; as well as the application analysis programs necessary to complete the analysis and processing functions of GIS; geospatial data is the blood of GIS, which refers to all the spatial locations based on the spatial location of the surface. The general term for information and even time-marked data, which can be words, numbers, images, graphics, audio, etc. It has various forms of existence and is the object processed by GIS applications, typically including two-dimensional vector maps, grids, etc. Grid image, digital tile, BIM building model, ocean body, 3D terrain, etc. [5-6].

Whether it is a GIS tool, a thematic GIS or a regional GIS, it usually has the functions of data collection, monitoring and editing, data processing, data storage and organization [7-8].

The data acquisition function can be used for the acquisition of geospatial data, and the data monitoring and editing functions can be used for the integrity analysis monitoring, numerical analysis, correctness analysis monitoring, etc. of the geospatial data. Information sharing and automatic data input have become important contents of GIS system research.

At present, the commonly used GIS databases are obtained by spatial expansion on the basis of relational databases, such as Oracle Spatial, Post GIS, etc. In terms of data organization, the most important thing is spatial indexing and query. At present, there are a large number of mature technologies and research results, such as Index and query of B-tree series, index and query of R-tree series, grid index and query, etc.

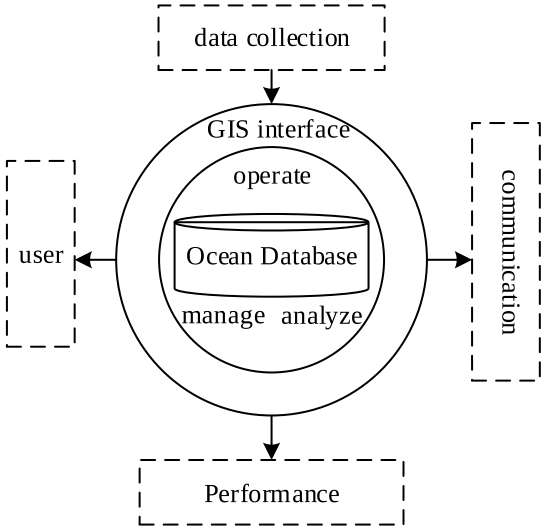

Figure 1. Composition of GIS

2.2. The Shortcomings of Traditional GIS in Marine Information Management (MIM)

There are a series of problems in the application of traditional GIS software to MIM. These problems are due to the increasing diversification of people's needs for MIM with the rapid development of society and economy, which makes MIM based on traditional GIS gradually exposed. On the other hand, there are some problems in the combination of MIM technology and traditional GIS technology [9-10]. This paper summarizes these issues into the following aspects:

(1) The degree of integration of the system is not high

With the deepening of the application of GIS technology in marine management, a number of related GIS systems have been established at home and abroad, but the professional models and spatial data models used in the databases of these information management systems are different. , the definition of connection methods and interfaces does not adopt a unified standard, which makes it difficult to integrate. In addition, each system lacks the data model required for the simulation of MR, and cannot effectively cope with the variable spatiotemporal data structure and process algorithms [11-12].

(2) Lack of general professional model support

From the scope of international research, the MIM of many countries has evolved from the traditional survey and mapping stage to the monitoring, simulation, and management-based stage. MIM is based on a large number of professional models and functional models. However, at present, there are serious technical barriers between many systems, and the integration with geographic information systems is not deep enough. Even only using GIS as a storage tool for marine information cannot provide diverse and practical analysis functions, and cannot solve the problem of MIM. A professional field establishes a common professional model.

(3) The data accuracy is not high and the data sources are limited

The data problem is the first problem that any information management system must solve. Traditional GIS has been faced with the problems of low data accuracy and limited data sources for a long time, which has become a major bottleneck restricting its development. Although aviation and aerospace remote sensing technology has developed rapidly in recent years, it can provide traditional GIS with a large amount of current image data and effectively improve the update of marine information. However, due to the complexity of MIM, there are still a lot of marine data that are difficult to obtain. . In addition, many existing marine data have problems of multi-source, heterogeneity, and large age span, which makes the quality of marine data vary, cannot guarantee high data accuracy, and is not conducive to the unified integrated management of marine information, which restricts the quality of marine data. The application of GIS technology in MIM [13-14].

2.3. Characteristics of Ocean Visualization Expression Based on WG Technology

The introduction of WG technology has brought a new development direction to the field of ocean visualization, and has deepened the expression effect and function of geographic information by means of symbolization and graphics. Compared with ocean visualization in the traditional sense, the characteristics of ocean visualization based on WG technology are expounded from the following aspects [15-16].

(1) Dynamic interactivity

The ocean visualization expression based on WG technology is dynamic and interactive. It can flexibly control and apply information transmission between the client and the server. At the same time, its database is constantly updated to ensure real-time performance. It is the space of WG. An important prerequisite for query analysis capabilities.

(2) Diversification of information expression

Due to the large amount of data, different formats, complex processing and other factors, there are many ways of expressing ocean visualization based on WG technology. , such as images, audio, video, etc. Therefore, the data information can be expressed more abundantly, completely and reasonably, and the features of geospatial information can be comprehensively displayed in an all-round and multi-angle manner, thereby expanding the content and functions of marine WG visualization.

(3) Diversification of information expression

The ocean visualization based on WG technology can not only express the spatial distribution law of data and its relationship in the geographic chart, but also reflect the development, change and dynamic law of ocean data through the description of the time dimension and by means of visualization methods. .

(4) Spatiality

Compared with the general visualization, the fundamental difference is that the ocean visualization based on WG technology has more obvious spatial characteristics, which can highlight the space and scope of the ocean information, and can combine the main body of ocean information with the geography. Spatial features are combined more closely [17-18].

2.4. Benefit Evaluation Method

(1) Entropy weight method

Due to the dimensional differences between different indicators, the range method should be used to measure the original data before calculating the total benefit of MR. In order to solve the zero condition after calibration, the data is processed as follows: xij=xij×0.99+0.01. Like the objective weighting method, the entropy weighting method can effectively overcome the errors caused by subjective factors. The specific calculation process is as follows:

Step 1: Scale the unscaled filter on the original index data.

For benefit-type indicators, use:

$$x'_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \tag{1}$$

For cost indicators:

$$x'_{ij} = \frac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}} \tag{2}$$

Step 2: Calculate the proportion pij of the jth index value in the ith area.

$$p_{ij} = x'_{ij} / \sum_{i=1}^{n} x'_{ij} (i = 1,2,\Lambda\ , n;\ j = 1,2,\Lambda\ , m) \tag{3}$$

Step 3: Calculate the entropy of the jth indicator

$$e = -k \sum_{i=1}^{n} x_{ij} \ln x_{ij} \tag{4}$$

In the formula: k=1, lnn; ej⩾1

Step 4: Calculate the difference coefficient gi.

$$g_j = 1 - e_j \tag{5}$$

Step 5: Calculate the indicator weight wi

$$w_i = \frac{1 - e_i}{\sum_{i=1}^{n} (1 - e_i)} \tag{6}$$

(2) CB index model

On the basis of calculating the benefits of each subsystem, the linear weighting method is used to calculate the CBs of my country's MR, as follows:

$$f(x) = \sum_{i=1}^{4} w_i \times u_i$$
$$f(y) = \sum_{i=1}^{3} w_j \times u_j$$
$$f(z) = \sum_{i=1}^{4} w_k \times u_k \tag{7}$$

$$f(t) = \sum_{i=1}^{3} (f(x) + f(y) + f(z)) \tag{8}$$

In the formula: f(x), f(y), f(z) and f(t) represent the evaluation indicators of the economic, social, ecological and total benefits of water resources, respectively; wi, wj, and wk represent the economic, social and Density and ecological benefit indices; ui, uj, and uk represent the standardized data of the initial values of economic, social, and ecological benefits of water resource evaluation indicators, respectively. f(x), f(y) and f(z) are between 0 and 1. The higher the value, the greater the benefit index.

3. Experimental Study

3.1. System Architecture of WG

Usually a WG application system will use several physical computers to store data, process data, make maps, publish services and access applications. These computers are at different levels and are generally described by system architecture. A complete WG system architecture includes various terminal servers and service providers using the system, as shown in Figure 2:

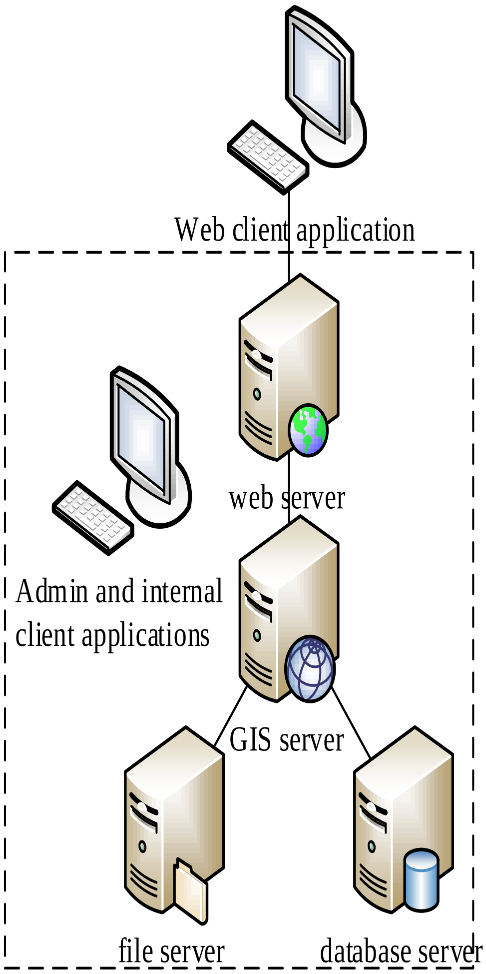

Figure 2. System architecture of WG

(1) Data server. Redundant storage mechanisms and regular backup scripts are often required to avoid data loss.

(2) GIS server. Used to create web services, such as creating mapping services, geometric object projection services, database search services, and other spatial analysis services. GIS server is the core of WG, so it usually requires high performance and strong data processing capability, and can be composed of one or more computers. For large-scale WG applications, multiple GIS servers can be divided into different groups according to different business functions, and different groups are in different services. For example, the server with the best performance can be used for data processing services, and the server with average performance can be used. For processing map processing services.

3.2. Construction Goals of the System

Constructing a MIM system based on WG is a system engineering that integrates complexity, comprehensiveness and professionalism to design and implement a system that integrates marine information collection, storage, management, query, analysis and visualization and many other functions. as the target. The system can be used not only as a tool for MIM, but also as a platform for government managers to analyze and make decisions on MR. Specifically, the construction goals of the system include the following aspects:

(1) Utilize existing open source software technologies such as WG to establish a complete marine business management database and marine information space database, and conduct unified management of current marine resource planning and mining information, laying a solid foundation for the construction of an integrated MIM system. Solid data foundation.

(2) To support the convenient and efficient management of marine information, it is required to have a friendly user interface and fast and accurate data analysis functions, and to update marine data in a timely manner.

(3) Use a unified national standard to classify and code MR, and then use a unified data organization and storage architecture to store marine information on this basis.

(4) Based on the application status of marine resource information, considering the personnel, equipment and timeliness of data collection, a dynamic marine information change operation and maintenance mechanism is established to facilitate accurate and timely maintenance of marine databases and ensure Real-time, shareable and accessible marine information.

(5) According to the actual needs of each business sub-department, establish a MIM subsystem as needed, realize the modularization and loosely coupled structure of system functions, and realize the automatic decomposition and reorganization of tasks at all levels in MIM office and decision-making. .

(6) Combined with the network sharing mechanism of WG, realize the dynamic and real-time sharing of marine information, and provide convenient and efficient marine information services for marine resource management departments.

(7) The scalability of the system platform should be fully considered in the process of building the system platform. This paper designs and implements the basic platform software of MIM based on WG. Different users can perform various functions on this basis according to actual application needs. Customized, so as to realize the dynamic configuration of various local function modules without changing the core software architecture.

3.3. Overall Architecture Design of the System

Web-based GIS MIM system consists of corresponding hardware, software, database and a series of basic systems. The structure is software and hardware respectively, the database is divided into graphics and attributes, and the functional element of the application system is the personal database. In this way, the functions of statistical analysis, query retrieval and visual output of marine information can be realized, and the actual needs of government and enterprise decision makers and managers for MIM can be met. The overall architecture design of the whole system is shown in Figure 3.

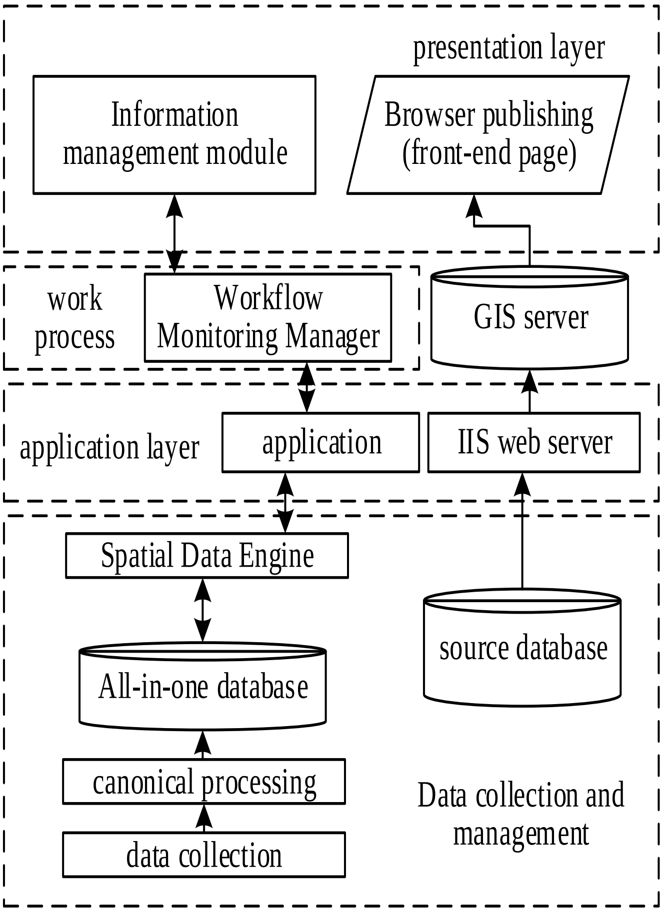

Figure 3. Overall architecture design of MIM system based on WG

4. Experiment Analysis

4.1. Time difference analysis of CB of MR

Through the calculation of the CB index of MR, the time evolution of the CB index of MR from 1 to 14 years was counted, as shown in Table 1.

Table 1. Time changes of my country's MR CB index in 14 years

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Benefit Index	1.27	1.26	1.26	1.28	1.38	1.35	1.39	1.32	1.34	1.36	1.28	1.31	1.22	1.26

It can be seen from Figure 4 that the average CB of MR in 1-14 years increased from 1.27 in 1 year to 1.39 in 7 years, and then decreased to 1.26 in 14 years, showing a fluctuating trend as a whole, indicating that China’s CB of MR during the study period. The development is unstable. In order to further reflect the change trend of China's CB of MR from 1 to 14 years, this paper divides it into the following four stages according to the fluctuation and evolution trend of the change trend of the CB index of MR.

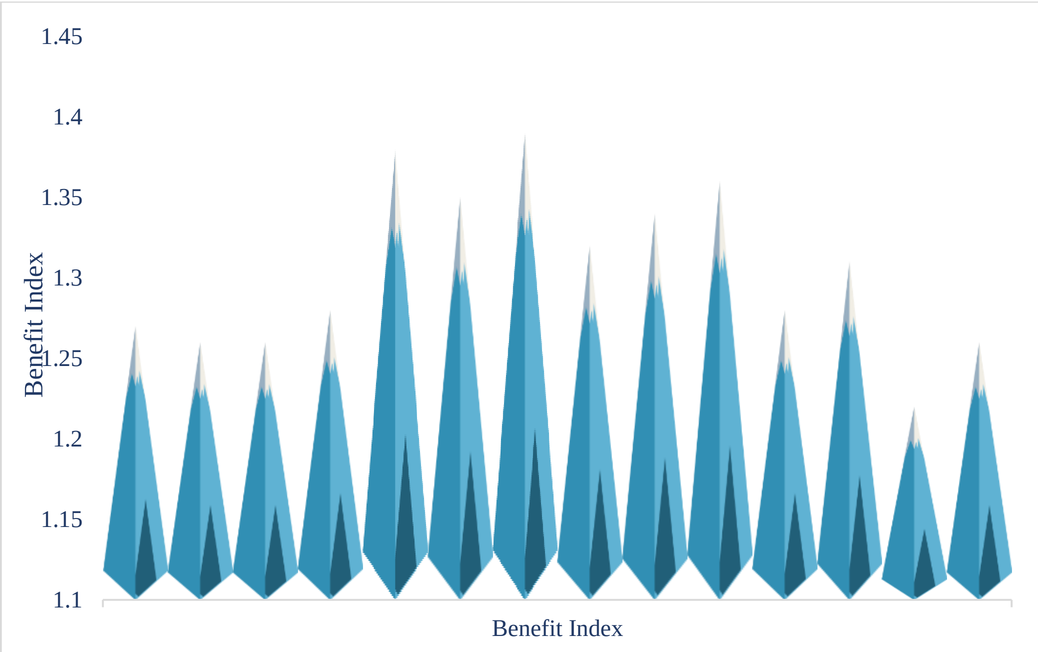

Figure 4. Time change chart of my country's MR CB index in 14 years

Phase 1: 1-3 years. The CB of MR decreased from 1.27 to 1.26, and the CB of MR remained stable within two years, indicating that the CB of MR showed a slight downward trend at this stage. The overall benefit shows a downward trend. Specifically, the economic benefit shows a slight decline in 2-3 years, the social benefit shows a slight decline in 1-2 years, and the ecological benefit shows a downward trend in 1-3 years.

The second stage: 3-7 years. The CB of MR has risen from 1.26 in 3 years to 1.39 in 7 years. The overall benefit of MR in 3-5 years has an obvious upward trend, from 1.26 in 3 years to 1.38 in 5 years. -7 years showed an overall upward trend, indicating that the CB of China's MR showed an overall upward trend and great volatility during this period.

The third stage: 7-10 years. The CB of MR dropped from 1.39 in 7 years to 1.36 in 10 years. The CB of MR dropped significantly in 7-8 years, from 1.39 in 7 years to 1.32 in 8 years. After 8 years, the CB increased slowly, from 1.32 to 1.32. 1.38, indicating that the CB of MR fluctuated at this stage.

The fourth stage: 10-14 years. The CB of MR dropped from 1.357 in 10 years to 1.260 in 2014. In 11-12 and 13-14, the CB of MR showed a slight upward trend, and 10-11 and 12-13 showed a sharp downward trend. It shows that the fluctuation trend of the CB of China's MR is obvious at this stage.

4.2. Analysis of Spatial Differences in CBs of China's MR

Based on the calculation of the annual average results of the CBs of MR from 1 to 14 years, the spatial differences of the CBs of MR in different regions of A-K are analyzed, as shown in Table 2, and the CBs of MR are divided into four levels.

Table 2. Statistics on the mean value of CBs of MR

Area	A	B	C	D	E	F	G	H	I	J	K
CB Index	1.12	0.86	1.46	1.21	1.29	1.56	1.68	1.89	1.32	1.13	0.84

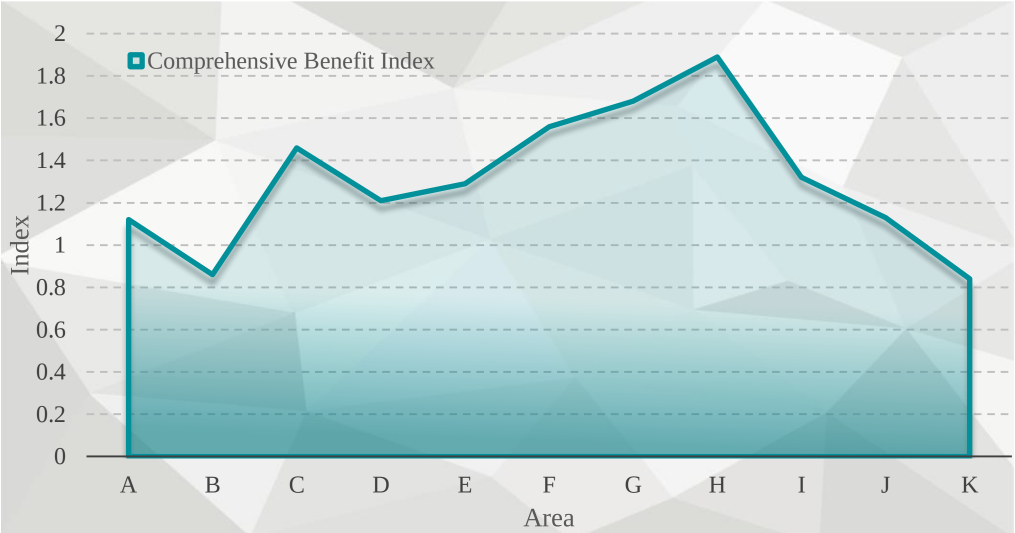

Figure 5. Analysis of the mean value of CBs of MR

(1) High-level area of CB of MR. It mainly includes H, F and G, and the CB index of MR is 1.89, 1.68 and 1.56 respectively. H's superior geographical location, vast coastal beaches, and numerous marine islands have made H a large marine resource and a strong marine resource economy. In recent years, the government has attached great importance to MR, accelerated the construction of the H economic zone, and has advantages in MR science and technology. . F and G are also large in MR. They are at the forefront of the country in terms of marine aquaculture output value and marine fishing output value per capita marine fishery production value, and the income level of fishermen is also relatively high. The development of resources is profitable, the fishery ecological environment is gradually improved, and the overall level of CBs of MR is high.

(2) Areas with high CBs of MR. It mainly includes C, D, E, and I, and the CB index of MR is 1.46, 1.21, 1.29, and 1.32, respectively. C promotes the construction of marine grasslands, increases the area of aquaculture and the output of aquatic products through shallow seabed sowing, etc., and expands characteristic marine brands such as sea cucumbers, abalone, scallops and clams. The output of MR has increased year by year, and the input-output ratio has exceeded 10 times. E, D and I have a large investment in MR science and technology, and fishery science and technology occupies an important position in industrial development. In addition, these areas are domestically leading in terms of infrastructure construction such as fishing ports and fishing boats, with a high level of fishery informatization and high quality of fishermen. , the breeding method and breeding structure are more reasonable, and the CB level of MR is high.

(3) Intermediate level area of CB of MR. It mainly includes two regions, A and J, and the CB index of MR is 1.12 and 1.13, respectively. A. The output value of marine aquatic products is low, and the output value of marine aquatic products is also low. In addition, the area and production of marine algae and shellfish are at a disadvantage in coastal areas. J Marine Fisheries Fahan is in its infancy. Although there is a vast Beibu Gulf, there are only three coastal areas: Qinzhou, Beihai and Fangchenggang. The fishery infrastructure is backward and the number of employees is small.

(4) Areas with low level of CB of MR. It mainly includes B and K, and the CB index of MR is 1.86 and 0.84, respectively. B is located on the coast of the Bohai Rim, the near-shore sea area is relatively closed, the marine aquaculture exceeds the carrying capacity of the sea area, and the aquaculture pollution is serious. K coastal fishery infrastructure is relatively backward, marine fishermen are mostly traditional fishermen, the efficiency and technology of mariculture and marine fishing are relatively low, the output of marine aquatic products is small, and the income of

fishermen is low.

5. Conclusion

In the process of building a GIS-based MIM system, the most important link is to establish a marine database. If the database construction is not perfect, it will directly lead to wrong results in marine data management and analysis. WG can effectively deal with the above problems and deficiencies. By establishing a database in a standardized way, it can achieve efficient management and accurate analysis of marine information. The MIM system based on WG can support multi-source, heterogeneous and massive marine information. Storage, management, analysis and visualization, such as various land parcel data, remote sensing images, spontaneous geographic information data on the Internet, traditional geographic data, and other statistical report data and file data, greatly broaden the data sources of traditional GIS and can Provide more scientific and powerful information technology support for MIM.

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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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