Research Article

Effect Evaluation of Eco-Environmental Big Data Resource Integration and Data Sharing Construction

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The application of big data in the field of ecological environment has achieved remarkable results, but there are still problems such as insufficient innovation and lack of shared service ability. This research takes the big data platform as the technical support and makes full use of advanced technologies such as internet of things, cloud computing, and big data to realize the integration of ecological environment big data resources and real-time data sharing. Through network technology, the ecological environment metadata can be automatically obtained from the internet and stored. When sharing ecological environment metadata, realize the data response and declassification of geospatial data for different user access levels, and finally safely feedback the ecological environment spatial big data integrated with the target ecological environment metadata and declassified geospatial data to the access initiator, so as to realize the centralized sharing of decentralized environmental information resources and give full play to the supporting role of big data, so that big data can be effectively applied in environmental monitoring. Find out the changes of pollution sources and pollutants through massive data, so as to provide necessary data support for the whole environmental monitoring.

1. Introduction

Ecological environment refers to the general term of the quantity and quality of water resources, land resources, biological resources, and climate resources that affect human survival and development. It is a composite ecosystem related to the sustainable development of society and economy. In recent years, with the development of social economy and the increase of human activities, in the process of using and transforming nature, various negative feedback effects harmful to human survival caused by the destruction and pollution of the natural environment have occurred more and more frequently, which have attracted people’s attention and attracted the high attention of relevant national departments [1]. Controlling and controlling environmental pollution is very important to the development of social economy and the safety of human life. How to scientifically and reasonably use the big data resources of ecological environment to carry out ecological environment assessment, monitoring, and early warning is extremely important. At the equal time, it can supply speedy and correct decision-making groundwork for the country-wide environmental safety branch to manipulate and manage air pollution [2]. In order to enable relevant departments to make accurate judgment and prediction on the possible development trend of environmental quality in the future,
so as to take targeted countermeasures, it is imperative to establish an ecological environment spatial big data integration and sharing platform and its implementation methods, which can not only reduce the repeated construction of environmental data monitoring nodes and make the environmental information resources be effectively utilized but also provide information for different places different units provide the sharing of environmental information resources to facilitate different departments to make timely and reasonable decisions on environmental conditions.

Although scientific research has been carried out to varying degrees in many scientific and technological fields, and a large amount of scientific data has been generated, such as a large number of geological survey data, meteorological observation data, environmental monitoring data, hydrological observation data, and topographic mapping data, most of these environmental information resources are scattered in the hands of different units, departments, and some researchers, many valuable environmental information resources have not been fully shared, resulting in repeated collection of data resources, unable to make full and effective use of these data resources, and also caused a lot of waste of human and material resources [3]. In addition, in consideration of the security of environmental information resources, in the process of sharing, corresponding sharing permissions should be given to different sharing objects in accordance with laws and regulations. For example, for senior departments such as national or provincial level, they can obtain all environmental monitoring data and weakly unclassified geospatial data, while for intermediate departments such as prefecture level or county level, most of the environmental monitoring data and strongly declassified geospatial data can be obtained, while ordinary personnel can only obtain a small part of environmental monitoring data and completely declassified geospatial data [4]. In addition, in the process of sharing, certain data security measures need to be taken to protect the information security of the sharing platform side and the user terminal side.

This paper gives full play to the supporting role of big data on the integration of eco-environmental big data resources and the construction of data sharing, so that big data can be effectively applied in environmental monitoring. Find out the change of pollution sources and pollutants through massive data, provide necessary data support for the whole environmental monitoring, and evaluate the effect of data sharing. The main contribution of this paper is to realize the sharing service and support of environmental monitoring data with the help of the integration of ecological environment big data resources, so as to provide effective data support and detection basis for the real-time dynamic assessment of the whole ecological environment.

The structure of this paper is as follows: Section 1 is the introduction, which introduces the research background, current situation, and significance of this paper; and Section 2 discusses the related work. Section 3 analyses the integration of eco-environmental big data resources, analyses the characteristics of eco-environmental big data, and introduces the integration operation mechanism. Section 4 analyses the structure and function of eco-environmental big data sharing, and Section 5 evaluates and analyses the effect of integration and sharing. Section 6 summarizes the full text.

2. Related Work

Ecological environment big data is a part of big data and has the general characteristics of big data. Eco-environmental big data refers to the use of big data concepts, technologies, and methods to solve a series of problems such as data collection and storage, calculation, and application in the field of eco-environment. It is the application and practice of big data theory and technology in the field of eco-environment. In the information age of continuous innovation and development, the exchange and communication of information are increasing day by day, accumulating a large amount of data. In the face of a variety of data formats, we should realize the wide sharing of data, so that a wider range of people can make full use of their own data and information resources, reduce the complicated and repetitive labour and related financial resources such as data collection and data collection, focus on the development and construction of appropriate applications and system integration, and improve the level of information service.

The data resources involved in the field of ecological environment mainly include ground monitoring data, remote sensing image data, geographic information data, social investigation data, and scientific research data. These data are distributed in many government departments such as environmental protection, land, water conservancy, agriculture, forestry, health, meteorology, and ocean [5]. Each department has its own information center, its own database with its own operating system, and user interface selected by itself; each unit is completely an independent system. Data are no longer related with every other, records sharing is difficult, and it is effortless to shape data island [6]. Throughout the applicable literature, the lookup on massive data, whether or not in theory, exercise, or technical application, can see the fashion and traits of tutorial research. First, in the process of depicting big data, there are many documents that tend to explain the concept of big data, and there are few introductions and explanations on the application of professional technical tools of big data [7]. Second, the application in the commercial field has increased. The technical application of big data has indeed benefited the economic activities of all walks of life. Therefore, there are relatively more research on big data in the commercial field, especially IBM, Google, and other information technology companies in information technology, which have sufficient economic strength to conduct special research [8]. Setting up a big data research center to develop professional core products and services of the industry is almost the standard configuration of these technology companies. Third, big data has been applied to the field of government management, and almost every major country with leading science and technology pays special attention to the development and application of big data, in the fields of environment, education, medical treatment, real estate, genetic science, and so on, as well as in the construction of intelligent transportation and intelligent city [9].
Many scholars have conducted considerable research on the relationship between environmental public services and big data. Among them, Jiang et al. made a detailed and in-depth study on the important environmental monitoring in the process of environmental management and initially proposed to build a “three-dimensional monitoring system of ecological environment.” At the same time, the author puts forward the problems of nonstandard monitoring data and insufficient analysis depth [10]. These issues are the issues that many expert large statistics personnel will stumble upon when dealing with, due to the fact evaluation and processing are a technology. The result of processing information requires people with multidisciplinary and interdisciplinary thinking to see more internal laws and connections [11]. Wang discussed the new opportunities faced by Guizhou’s big data industry under the new normal, referring to the four-level environmental protection network of ministry of environmental protection, province, city, and county established in Guizhou and the software system of “four platforms, three applications and six integration” focusing on emission reduction services [12]. Among them, “digital environmental protection” is to use digital and information technology means to mine and sort out environmental protection data, integrate with environmental protection business, and finally make environmental protection engineering a scientific and public system engineering, which is also the key to the use of big data. Hua and Zhou did not mention the topic of environmental monitoring in the research of environmental governance [13]. By capturing various information related to environmental protection released on the internet, focusing on special topics, carrying out public opinion analysis, and finally forming briefings, reports, and other information, we can master the public’s attitude towards the environment.

3. Integration of Ecological Environment Big Data Resources

3.1. Analysis of Big Data Characteristics of Ecological Environment. Eco-environmental information is the basis for environmental monitoring, analysis and evaluation, simulation prediction, and planning decision-making, while eco-environmental spatial data is the quantitative or cartographic representation of eco-environmental information [14]. As a kind of geospatial data that reflects the temporal and spatial relationship between human forces, the state of the system, human feedback, and the environmental effects shown by the system, as well as its quantitative proportion and characteristic properties, the spatial data of ecological environment has a series of unique characteristics, which are highlighted as follows:

(a) Spatial Reference and Spatial Topological Features. The constituent elements of ecological environment spatial data include four parts: space, attribute, time, and comprehensiveness, as shown in Figure 1. First of all, environmental spatial data are always associated with geographical entities on the earth’s surface at a certain spatial location [15]. If the urban elevated pollution source has a certain geographical coordinate position, the rainwater and flood runoff in the basin usually has a stable flow direction and spatial range, that is, it is a kind of spatial reference. Second, environmental spatial data also express the spatial relationship between geographical features, including area, length, connection, adjacency, and connectivity, that is, spatial topology [16]. For example, urban pollutant discharge outlets are spatially represented as the intermediate connections between a certain number of pollution sources and sewage collection pipelines. Different discharge directions of pollutants will control the different impacts of pollution sources on the environment

(b) Temporal Characteristics. It refers to that the same geographical entity has different eigenvalues in different time intervals and shows the characteristics of time series. For example, the coastal tidal current level, local atmospheric boundary layer parameters and automobile exhaust emission source intensity change with time, and the urban land use structure and urban area also show a trend of change and expansion in a long time

(c) Distributed Features. It refers to the heterogeneity of the site and the subject specificity of the environmental spatial data. The storage, update, and use of environmental spatial data are often not physically in the same place and owned by different people or organizations, but they can be logically linked based on the correlation of geoscience laws, environmental processes, and spatial entities through computer networks

(d) Multidimensional and Multiscale Features. Multidimensional definition environmental spatial data involves multidimensional features in geospatial, multi-level, and multilevel features in time and attributes. For spatial entities and geoscience and environmental processes, multiscale refers to the size of the deployment range of the same or similar geoscience environmental phenomena on the earth’s surface, the duration of geoscience environmental processes, and the complexity of the process. For the environmental spatial data itself, the scale shows resolution or accuracy, and large-scale data means low spatial-temporal resolution and less attribute classification

The above unique characteristics of ecological environment spatial data determine that when people solve complex environmental problems based on distributed environmental management decision support system and spatial database, they must integrate complex spatial data in order to make efficient and comprehensive use of various spatial data layers with different sources, different temporal and spatial scales, different formats, and different accuracy.

3.2. Structure of Eco-Environmental Spatial Data Integration System. Spatial data integration of ecological environment is
a system. The mechanism and method to solve data heterogeneity and project requirements should be reflected in the data integration system. From the action mechanism of data integration, the operation status of data flow in integration, and the actual application of spatial data integration, the author gives the structure of ecological environment spatial data integration system, as shown in Figure 2.

The function of network supported integrated system interface is to run through all modules in the integrated system, decompose the problems raised by users, and control the function flow of the system. The data retrieval and query function block searches for qualified data sets in distributed spatial data through metadata according to user needs and feedback the metadata content of the data set to the system to provide reference for the next operation of the system. Data integration block is the core module of the built-in system, it is based totally on the feature of GIS, and some different features are delivered to operate the precise processing of spatial attributes and associated relationships of facts sets, so as to shape certified logical or bodily statistics units. The geoscience environmental rule's function block is equivalent to a geoscience expert knowledge system, which provides a series of rules related to ecological spatial data [17]. It serves the detection, evaluation, and control of data quality; the processing of specific data entity features in integration; and the processing of some features in newly formed data sets. The data preprocessing module logically or physically gathers the data to be integrated according to the requirements put forward by the system. Check and deal with the consistency of the external characteristics of the integrated data and the characteristics of the data itself, complete operations such as data segmentation. The metadata function block provides data set metadata mode and generation function [18]. Record the dynamic information about the system and data in the process of system processing to assist the integrated system to realize other operations. Its function is to control the quality of data, set various parameters affecting data quality in system control integration processing, and evaluate the integration results by using data quality standards.

3.3. Ecological Environment Big Data Integration Operation Mechanism. Data integration can be divided into three stages: integration data preparation, integration, and integration result expression, as shown in Figure 3. The operation mechanism of ecological spatial data integration system is the demand of network interface for data users is decomposed into basic data demand. Query and obtain possible data conditions from metadata, i.e., candidate data. The candidate data are preprocessed and integrated by using geoscience rules and environmental mechanism [5]. Finally, the interface system feeds back the results to the user, and each module of the system is an interrelated whole. The network support is the operation platform of the system. Data retrieval and query, data integration, geoscience and environmental rules, data preprocessing are the basis and implementation modules for specific processing problems in the integration [19]. Metadata is the basis for normal data processing and ensuring data quality after processing. Data quality control runs through the whole integrated system.

4. Structure and Function of Ecological Environment Big Data Sharing System

4.1. Overall Architecture of the System. The shared service system can be divided into two subsystems: intranet and extranet. Considering the source of data, the system design should fully consider the centralized transformation of achievement data and the updating and reporting of future
data. Considering the application service of data, the system construction shall fully consider the data exchange interface and information service interface with other application services. The survey and evaluation result data can be collected and handed over according to the needs of other application services and can provide fast and diverse data services for

![Diagram]

**Figure 2:** Structure diagram of application-oriented eco-environmental big data integration system.

![Diagram]

**Figure 3:** Integration process of environmental big data.
The system web service, the portal provides a uniform user login, so as to realize the concentration and integration of various information resources and business applications and achieve the all-round sharing of information resources.

The shared service system is a complex system, and the data will involve the complex application analysis of various components of the national ecological environment background data set, the national ecological remote sensing data set, and the national ten-year change survey results data set of ecological environments. Among them, the authenticity and real-time of achievement data transmission is particularly important [24]. Achievement data transmission should take the business process of cooperation between shared resources as the carrier, and the extraction, optimization, and design of achievement data can be carried out on the premise of standardized shared business process, so as to ensure the authenticity and effectiveness of achievement data.

Therefore, in the process of database construction, a business modelling method and tool for complex system engineering analysis in line with the standards and specifications of the national geographic information platform are used as auxiliary support to sort out the data resources of the ecological decade, and the standardized data element design is adopted to avoid data partition between databases and repeated construction caused by different data formats. Moreover, it is necessary to adopt the corresponding model management platform for unified management [25]. The platform should meet the requirements of the application of the third-generation network technology, that is, the maximization and sharing of information technology, the combination of services and efficient development, the development of interoperability, distributed heterogeneous, humanized and adaptive software, and the construction, management, service, and transaction of software information resource database [26, 27]. It conforms to the emergency business model resource management system developed based on SOA architecture and reflects the resource-based, business-oriented, and service-oriented concepts of the model.

5. Results and Analysis

5.1. Analysis of Index Weight. Big data sharing of ecological environment includes data resource construction capacity, technical capacity, organization and management, shared service, effect, and other indicators. Using matrix judgment and group decision-making calculation, the weight of each level-1 index is obtained, and the consistency proportion of the matrix is judged. Through the consistency test, the four level-1 indexes are ranked as service efficiency and impact, platform function, data resources, and operation management according to their weight from high to low. Weight analysis of primary indicators for performance evaluation of data sharing platform is shown in Figure 5.

The weight of each secondary index can also be obtained by matrix judgment and group decision-making calculation. According to the weight of primary index and its secondary index, the comprehensive weight of each secondary index...
can be obtained. Using this calculation formula, the results are shown in Figure 6.

5.2. Analysis of Integration Results of Eco-Environmental Big Data Resources. After the rapid development of ecological environment construction, a large number of vertically and horizontally connected environmental protection business systems have been built. However, due to the nonuniform standard format and technical route of business data, there are different degrees of data separation in reality, forming a data island. The core of big data is data resources, and the difficulty of comprehensive integration and sharing of data has always been a prominent problem restricting the development of big data. Without data sharing, big data cannot be formed. Therefore, data integration and sharing are the premise and foundation for the construction of eco-environmental big data. In terms of the integration and sharing of data resources within the environmental protection system, an environmental data resource center has been established. In terms of data resources, business data such as environmental statistics, pollutant census, environmental quality, pollutant discharge permit, environmental monitoring, supervision and law enforcement, emergency command, nuclear, and radiation have been gradually integrated; information resource sharing among business departments has been formed; the business coordination among various departments has been strengthened. The ecological environment is diverse and complex, and there are many data related to the ecological environment. Therefore, the big data of ecological environment is not only distributed in the field of environmental protection but also includes the big data of water conservancy, forestry, land, meteorology, transportation, ecology, planning, and other departments, involving multifields, multidepartments, and multisource data. Only when different types of eco-environmental big data are connected, collided, and shared with each other can the value of eco-environmental big data be released. Therefore, in order to tap the potential value behind big data, opening up the link channel of eco-environmental data resources outside the environmental protection system is the key, and it is also the premise and foundation for realizing the real integration of data. Integrate assessment results of departments and data areas are shown in Figure 7.

In terms of the construction of ecological environment data disclosure platform, 45 environmental protection departments have built environmental data disclosure platform relying on websites. In order to better evaluate the construction of the platform, it will be evaluated from three aspects: public content, data timeliness, and convenience of the platform. Each index will be assigned by five grades: very good, good, general, poor, and very poor, and the corresponding assignment will be 5, 4, 3, 2, and 1. Finally, seven environmental data disclosure platforms got 13 points, 12 points, 17 points, 10 points, and 9 points. Among them, the data resources of air automatic station, river section water quality, and drinking water source of Hebei ecological environment information comprehensive release platform cannot be viewed, but only the information of nature reserves can be viewed. Evaluation results of timeliness and convenience of data are shown in Figure 8.
6. Conclusion

The construction of eco-environmental big data has achieved a breakthrough in the integration and sharing of data resources. Environmental protection departments at all levels have gradually integrated business data such as atmosphere, water, soil, nuclear and radiation, environmental impact assessment of construction projects, ecology, supervision and law enforcement, emergency response, issued data exchange specifications, and data resource directory standard system, and breaking the data island is no longer a piece of paper. However, the construction of eco-environmental big data is still in its infancy, there are many deficiencies in management and application, the degree of data sharing is not high, and the scope of data disclosure is narrow. Although the environmental protection department has gradually integrated the eco-environmental data in the field of environmental protection, only a few environmental protection departments/bureaus have integrated the eco-environmental data generated by other departments such as meteorology, land, water conservancy, agriculture, and transportation, which have not fully realized the data sharing, and the data resources have not been fully utilized. In view of the deficiencies in the construction of China’s eco-environmental big data, the construction of eco-environmental big data in the next few years urgently needs to be carried out; establish an organization to support the development of eco-environmental big data; implement the integrated management of environmental data collection, processing, disclosure, and technical support; and expand the relevant functions of the environmental information center, in addition to information planning, the construction, and maintenance of environmental information network, the functions of data collection, processing, transmission, storage, processing, and sharing should also be included. Accelerate
Figure 7: Integrate assessment results of departments and data areas.

Figure 8: Evaluation results of timeliness and convenience of data.
the construction of ecological environment big data platform, continue to integrate data resources in various business areas of environmental protection system in accordance with big data management and standards, and promote data sharing with water conservancy, land, meteorology, electric power, planning, and other relevant departments through sharing agreements, so as to realize the interconnection of ecological environment data. It is suggested to carry out eco-environmental big data cooperation with the help of international environmental cooperation platform to realize the connection between China’s eco-environmental big data and similar international eco-environmental big data platforms. In the next few years, the construction of eco-environmental big data urgently needs to be carried out; the organization supporting the development of eco-environmental big data needs to be established; the integrated management of environmental data collection, processing, disclosure, and technical support should be implemented; and the relevant functions of the environmental information center should be expanded. In addition to information planning and the construction and maintenance of environmental information network, the functions of data collection, processing, transmission, storage, processing, and sharing should also be included.

Data Availability

All data, models, and code generated or used during the study appear in the submitted.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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