A Preliminary Study on the Construction of a Natural Resource Comprehensive Survey System

Jie Bai, Ming Li

Comprehensive Survey Command Center for Natural Resources, China Geological Survey - Beijing, China - baijie23@mail.cgs.gov.cn，lm18910077797@163.com

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Abstract

The establishment of a comprehensive survey, monitoring and evaluation system for natural resources is important for determining the background of China's natural resources, fulfilling the "two unification" responsibilities of the Ministry of Natural Resources, and implementing the construction of an ecological civilization. According to the task requirements of the unified survey and monitoring of natural resources, we summarize the progress of natural resource management systems, monitoring systems, technical development and implementation of major projects, propose upgrading the "3rd National Land Resource Survey" to "the 1st Comprehensive Natural Resource Survey", and explore the construction of natural resource survey systems. Combined with the pilot project of comprehensive investigation of natural resources with multiple elements, the next major work for the comprehensive investigation of natural resources is to accelerate the formulation of standards and specifications, carry out application demonstrations, and establish and improve the working mechanism and investigation team.

1. Introduction

To plan development from the perspective of harmonious coexistence between humans and nature, it is necessary to have a comprehensive, holistic, and systematic understanding of natural resources, clarify the monitoring objects of natural resources, understand the background and dynamic spatiotemporal changes in natural resources, comprehensively analyze their development, protection, and utilization status, and promote the formation of a new modern construction pattern of a harmonious development between humans and nature. Many international organizations and developed countries have shifted natural resource management from simple development and utilization to sustainable management and comprehensive coordinated management (Ma et al., 2022). Countries with rich resources, such as the United States, Russia, and Canada, have established national departments for comprehensive natural resource management from a holistic and systematic perspective supplemented by legal, economic, administrative and other means to fully utilize the overall function of natural resources. Moreover, the comprehensive and coordinated development of resource development and environmental protection should be achieved. (Qian, 2004; Feng et al., 2021). China has a vast territory with several natural resources and different intertwined resources. Only by implementing comprehensive natural resource management and developing and protecting natural resources from the perspective of overall ecosystem protection and spatial planning consistency can we ensure the implementation of national strategies. This requires the concepts of integrity, systematicity, and relevance under the comprehensive management of natural resources to penetrate each stage of investigation, monitoring, analysis, and application. Natural resource investigation is fundamental and preliminary work that involves natural resource management. Therefore, it is necessary to begin with the most basic investigation process for research and exploration. In the context of the responsibility of "two unification" of natural resources, it is necessary to build a national natural resource map and then systematically manage mountains, rivers, forests, fields, lakes, and grasses as a life community.

2. Steady Progress in Natural Resource Survey and Monitoring

2.1 Continuously Improving the Management System

With the development and progress of society, the institutional system, methodological concepts, and mechanism models of natural resource management in China are constantly undergoing transformation and optimization. Since the reform and opening in 1978, rapid economic development has driven the consumption of resources, leading to an increasingly strong voice for the scientific utilization and protection of natural resources. In the second institutional reform of the State Council in 1988, seven units closely related to major natural resources, including the Ministry of Geology and Mineral Resources, the Ministry of Water Resources, the Ministry of Forestry, the Ministry of Agriculture, the National Land Administration, the National Oceanic Administration, and the National Meteorological Administration, were assigned administrative responsibilities for natural resources. This changed the situation of multiple resource management and inadequate legal mechanisms, and natural resources entered the initial exploration stage of classified management. With the establishment of the Ministry of Land and Resources in 1998, the Ministry of Geology and Mineral Resources, the National Land Administration, the National Oceanic Administration, and the National Bureau of Surveying and Mapping, which are closely related to natural resources, formed the Ministry of Land and Resources (retaining the National Oceanic Administration and the National Bureau of Surveying and Mapping as the national bureau of the Ministry of Land and Resources), effectively supporting the country's overall management of natural resources such as land, minerals, and oceans, which marked a crucial step forward for China's natural resources from "division" to "unification". However, the management needs of natural resource management departments are different, and their principles, standards, connotations, and methods of natural resource classification are not unified, resulting in a lack of comparability between natural resource surveys and statistical data (Feng et al., 2021; Song et al., 2022).

After the 19th National Congress, with further clarification of the needs of the national government and the deepening of the concepts of ecological civilization construction and natural resource life community, the Ministry of Natural Resources was established in the new round of national ministerial reforms in March 2018 to carry out unified investigations and monitoring of seven natural resources, including land, minerals, forests, grasslands, and water bodies, and fulfill the responsibility of "two unification". The unified implementation of the responsibilities of all natural resource asset owners and the unified exercise of all land use control and ecological protection and restoration responsibilities (Shen et al., 2020) indicate that natural resource management has entered the era of comprehensive management at the national level. The Natural Resources Investigation and Monitoring Department was subsequently established and is responsible for developing an indicator system and statistical standards for natural resource investigation, monitoring and evaluation; establishing a comprehensive and standardized system for natural resource investigation, monitoring and evaluation; implementing basic and specialized investigations and monitoring of natural resources; and supervising and managing the results of natural resource investigation, monitoring and evaluation, as well as publishing information. This has put an end to the situation of decentralized management of natural resources in terms of management systems, solved the situation of "segmented" supervision by administrative agencies, provided a foundation for the subsequent introduction and continuous improvement of regulations, standards, and systems in the fields of natural resource investigation, monitoring, and management, and provided strong institutional guarantees for ecological civilization construction.

2.2 Preliminary Construction of the Investigation and Monitoring System

The Ministry of Natural Resources, guided by the theories of natural resource science and Earth system science, issued the "Overall Plan for the Construction of a Natural Resource Survey and Monitoring System" (hereinafter referred to as the "Overall Plan") in 2021 (Chen et al., 2022), proposing a comprehensive natural resource classification standard. This requires that the new natural resource classification system inevitably adapts to the strategic needs of the new situation. The Overall Plan specifies seven natural resources, including land, minerals, forests, grasslands, water, wetlands, sea areas, and islands, as survey and monitoring objects and requires the establishment of comprehensive natural resource classification standards, providing basic data for a comprehensive investigation of the status and changes of natural resources in China. Moreover, the investigation and surveying of ground substrates, which focus on interactions and close connections between multiple natural resources, are also proposed for the first time in this plan. On the one hand, it helps to shift the understanding of natural resource elements such as crops, water, forests, grasslands, etc., from a single quantitative bottom line to a combination of quantitative and quality bottom lines. On the other hand, it provides a scientific decision-making basis for the Ministry of Natural Resources to exercise its "two unified" responsibilities and is helpful for understanding natural resource elements to shift from the listing of direct observation indicators to a comprehensive evaluation of the organizational structure and functional effects of the life community system, highlighting the implementation of the integrated ecological civilization concept of "mountains, rivers, forests, fields, lakes, grasslands, and sand".

2.3 Information Technology Promotion

With the flourishing development of China's aerospace and aviation remote sensing industry, the construction of the Beidou system and CORS station network has become increasingly mature, providing an increasingly perfect space-based information service network for natural resource investigation and monitoring. The number of satellites in orbit has been increasing annually, and they have achieved great improvements in terms of resolution, accuracy, and other aspects. The goal of serialization and spectral transformation has been achieved, and data resources are becoming increasingly abundant. The application scope and depth are constantly expanding, providing important technical support for objective, real, accurate, and real-time understanding of the basic and changing situation of natural resources (Wang, 2022). After more than 20 years of development, unmanned aerial vehicle aerial remote sensing technology has established a systematic industrial application system in fields such as land surveying, marine island and reef surveying, geological disaster application, and national emergency rescue. The established "sky-air-ground" three-dimensional comprehensive observation system has been important in the unified investigation and monitoring of multidimensional data such as quantity, quality, structure, ecological status, and changes in natural resources. In the future, with the continuous innovation of networking intelligent control, remote sensing big data cloud processing technology, and unmanned aerial vehicle remote sensing networking practicality, it will continue to provide a solid data foundation for the main business of natural resource management and major projects (Yan et al., 2019; Liao et al., 2021). With high-precision positioning, speed measurement, and timing capabilities, the Beidou system has gradually entered the stage of global services, large-scale applications, and industrial development (Yang, 2020). It provides safe and efficient spatiotemporal data support for natural resource management work, such as land spatial planning, investigation and monitoring, ecological protection and restoration, disaster warning and prevention, and surveying and mapping geographic information, effectively improving the real-time, precise, and digital level of management and promoting high-quality development of natural resources.

With the continuous upgrading and improvement of software and hardware equipment such as the Land Survey Cloud Platform (Li, 2020) and the Forest and Grass Wet Field Survey Software (Feng et al., 2015), the exploration and practice of natural resource surveys, monitoring, analysis and evaluation technology systems (Yan et al., 2022), as well as the construction and promotion of application service platforms based on large amounts of data, cloud architecture, and distributed storage, all provide necessary technical support for comprehensively improving natural resource information services and management decision-making.

2.4 A Series of Successfully Implemented Key Projects

Since the 1970s, the country has successively carried out special investigations, censuses, and inventories of major natural resources nationwide. The national land survey, organized by the former Ministry of Land and Resources, takes the state of land use as the survey subject and is conducted every 10 years. The land change survey is conducted annually on December 31, and the geographical and national conditions monitoring is organized by the former National Bureau of Surveying, Mapping, and Geographic Information. The 2015 geographical and national conditions survey data were updated annually on

June 30. In addition, the Ministry of Water Resources and the former State Forestry Administration have conducted special investigations on forests, grasslands, water resources, etc. In response to the ground substrate survey involved in the "Overall Plan", the Ministry of Natural Resources developed a ground substrate classification plan. Ge et al. (2022) preliminarily constructed a ground substrate survey technology and method system from two dimensions, survey process and survey content, providing a reference for the construction of a natural resource survey technology system. The Natural Resources Comprehensive Survey Command Center of the China Geological Survey organized and carried out ground substrate surveys in 83 key protected counties (cities, districts, and banners) in the typical black soil area of Northeast China.

Many departments have carried out much work in natural resource investigation and monitoring and have made several achievements. Some technical means are also very mature, but there is a need for continuous improvement in data integration, sharing, and deep development applications. Thus, we ask the following questions: How can various investigation indicators and technical regulations be coordinated? How can work tasks be coordinated, technical processes be optimized, and more accurate and efficient investigation and monitoring be achieved? These are all issues that need to be continuously solved to achieve comprehensive investigation and monitoring of natural resources in the future.

3. Connotation of a Comprehensive Survey of Natural Resources

Based on the systematic concept that mountains, rivers, forests, fields, lakes, and grasses are a community of life, we aimed to upgrade the "3rd National Land Resource Survey" into the "1st Comprehensive Natural Resource Survey", following the positioning of "continuity, stability, transformation, and innovation" based on the results of the "3rd National Land Resource Survey", comprehensively sorting out, refining, and improving the basic data and standards and specifications of natural resources, and determining land, minerals, forests, grasslands, water, and wetlands. The boundaries and basic attributes of natural resources, such as sea areas and islands, are clarified through data integration, remote sensing interpretation, supplementary surveys, and other methods. A natural resource survey base map was produced with remote sensing image support, consistent category identification, global coverage of elements, and no conflicting boundaries. By fully utilizing modern information technology tools such as spatial information technology, big data, cloud computing, and blockchains combined with traditional ground survey methods, we conducted comprehensive surveys of natural resources at different temporal and spatial scales to identify the quantity, quality, distribution, structure, function, ecological status, and changes in natural resources. We explored the technical method system, element indicator system, and survey implementation mode of integrated surveys of multiple categories of natural resources and established a series of standard specifications for comprehensive investigations of natural resources. Multiple natural resource data collection and management, fusion and integration, analysis and expression technologies should be innovated. Research on the interaction and mutual feedback mechanisms of natural resources should be deepened, evolutionary trends should be predicted, and services for natural resource management should be supported.

Land spatial planning and socioeconomic development provide a scientific basis for the Ministry of Natural Resources to fulfill its responsibilities of "two unification". From this, analyzing the connotation of comprehensive investigations of natural resources includes the following aspects:

(1)One is the comprehensive investigation of types, which is a comprehensive investigation of the element conditions of seven natural resources, including land, forest, grassland, wetland, water, ground substrates, and minerals;

(2)The second is the integration of technical methods, which refers to the use of technologies such as space, aviation, ground and borehole survey technology that are integrated for natural resource survey elements within the task area;

(3)The third is the synthesis of survey indicators, which refers to the comprehensive survey data obtained from five aspects—type, quantity, structure, quality, and function—through a one-time field operation for the seven natural resource elements mentioned above;

(4)The fourth is the integration of spatial scales, which refers to both the design and implementation of surveys at different spatial scales, including points, lines, and surfaces for different natural resources within the survey unit, as well as the inclusion of aboveground and underground surveys in three-dimensional space;

(5)The fifth is the synthesis of a display platform based on 3D data warehousing, which is also used to demonstrate or provide an interface for interacting with a uniform system;

(6)The sixth is the integration of organizational management, which means breaking down the barriers of engineering projects; coordinating and unifying planning and design, investigation and monitoring, data analysis, and result expression; and integrating basic and special investigation forces to form a comprehensive investigation team.

4. Construction of a Natural Resource Comprehensive Survey System

The goal of a comprehensive survey of natural resources is to comprehensively identify the types, quantity, quality, structure, and functional characteristics of major natural resources such as land, forests, grasslands, wetlands, water, ground substrates, and underground resources (minerals, underground spaces) in the study area. Based on important indicators, the focus should be on the major natural resources and the mechanisms and laws of their interaction and influence. According to the workflow, the comprehensive survey system for natural resources can be divided into 7 steps (Figure 1): Data collection, indicator selection, basemap production, sample plot layout, field investigation, software development, and analysis and evaluation.

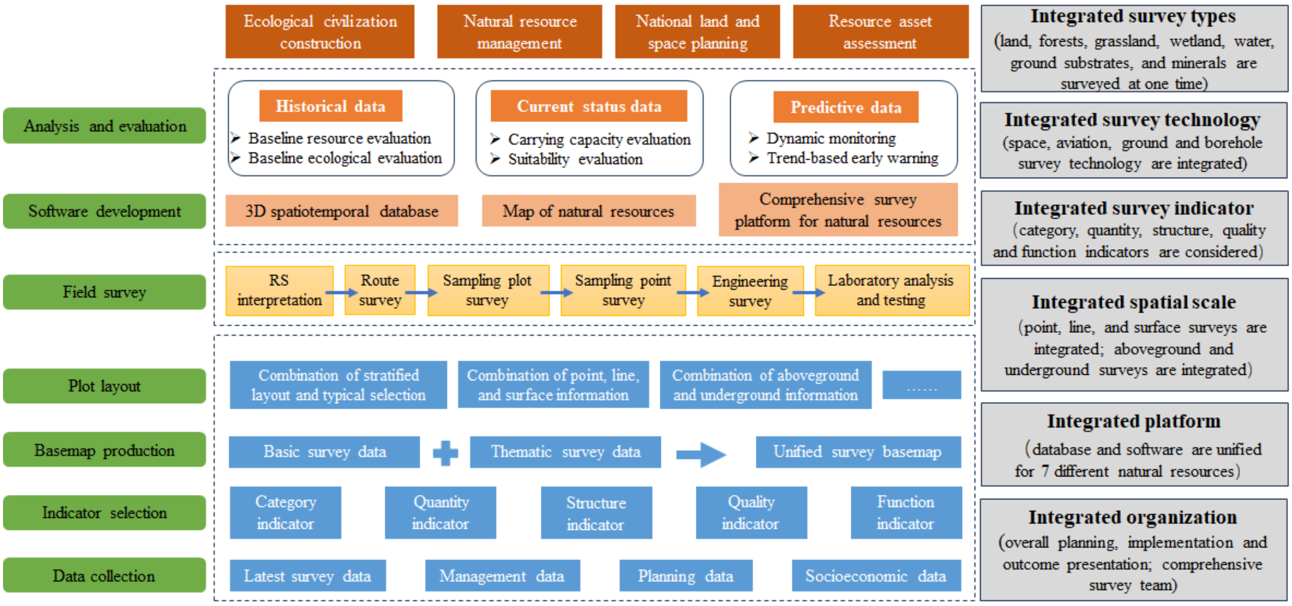

Figure 1. Flowchart of the comprehensive natural resource survey system

4.1 Data Collection

Within the scope of the task area, data collection is focused on collecting and organizing information such as current situation data, management data, planning data, and socioeconomic data to form a background dataset, including national land survey data, geographic national survey (monitoring) data, and various special survey data, such as land/forest/grassland/wetland/water data. Additionally, the latest aerospace/aviation remote sensing data, historical climate data, technical specifications, standards, policies, plans, implementation status, and management data related to various natural resources are also used.

The content, data structure, and attribute information of natural resource survey results should be comprehensively analyzed, the quality of survey results with poor data availability and accuracy should be evaluated, and the best results should be selected. The processing of multisource heterogeneous data should be standardized; mathematical foundations, data formats, and semantic models should be unified; and a foundation for the production of natural resource survey maps and the implementation of special survey work should be provided.

4.2 Indicator Selection

Analysis and research for the collected data and technical specifications related to natural resource surveys and monitoring should be conducted, the classification results of domestic natural resources should be fully drawn on and absorbed, the needs of natural resource management should be met, and the characteristics of natural resources in the work area should be combined to develop an indicator system for comprehensive natural resource surveys (Table 1). Moreover, the technical regulations for comprehensive natural resource surveys should be improved, and technical guidance for the development of comprehensive natural resource surveys should be provided.

4.3 Basemap Production

The scope of special natural resource patches such as arable land, forests, grasslands, water, wetlands, minerals, deserts, and biology is divided into special areas based on the national land "3rd National Land Resource Survey" data as the base plate, which refers to the basic geographic information database and standardized special survey data of natural resources. Full-coverage area change detection by remote sensing data is carried out, and a comprehensive survey base map of natural resources is created by hierarchical classification, initially resulting in consistent category recognition, with global coverage of elements, no conflicting boundaries, and independent layers, ensuring the situation and scientific accuracy of the base map.

The survey accuracy of different survey areas should vary according to the survey scope. In principle, regional/watershed-scale (provincial) surveys should be carried out with a scale accuracy of 1:100000 to 1:500000, key areas (city level) should be carried out with a scale accuracy of 1:250000 to 1:100000, and typical areas (county, township, village level) should be carried out with a scale accuracy of better than 1:50000. Local areas need to be chosen with a 1:2000 or finer scale survey based on factor indicators.

4.4 Layout of the Sample Plots

Within the determined base map range, based on the existing standards and specifications resources and in accordance with the principles of comprehensive coverage, reasonable distribution, and sufficient quantity, a combination of systematic sampling and balanced sampling is adopted to lay out survey plots, squares, lines, and points for various resources. The layout of survey plots should determine the survey accuracy based on the survey type and survey area. Taking forest, grassland, and wet-land sampling surveys as examples, the sampling accuracy of forest stock, grassland yield, and grassland comprehensive vegetation coverage in provincial-level administrative units and regions/watersheds should not be less than 90%, and the sampling accuracy of forest stock, grassland yield, and grassland comprehensive vegetation coverage in municipal administrative areas should not be less than 85%.

The layout method of comprehensive natural resource survey sample plots should be integrated with sampling frameworks and layout sample plots such as those used in special surveys.

For example, conducting forest resource surveys can inherit the sampling system framework and fixed sample plots of the National Forest Resource Continuous Inventory and National Forest Resource Surveys while reducing costs and improving compatibility and sharing before surveys. Furthermore, it is also necessary to consider the combination of technical methods for optimization. Multiple methods, such as remote sensing surveys, ground surveys, analysis and testing, and model construction, can be used, and the mechanical layout can be combined with typical selections; moreover, point line surface combinations and digital map combinations can be used to obtain multidimensional information from multiple elements, such as trees, shrubs, grass, water, and soil.

Category	Type	Quantity	Structure	Quality	Function
Land	soil type, status of land use, second-level class of arable land	area	land ownership, cropping system, crop type, crop maturity system	soil layer thickness, soil organic matter content, soil texture, soil pH value, slope gradient, elevation, crop yield, soil bulk density, soil nutrient element content	agricultural land carbon sink, water source conservation index, fertilizer retention capacity
Ground substrates	genetic type, landscape type, cover type	morphology, area, thickness	ownership	color, texture, capacity, specific gravity, type of microorganism, organic matter content	carbon sink, water source conservation index, fertilizer retention
Forest	forest type, vegetation type, dominant tree species	forest coverage rate, area of various types of forests, forest reserves (standing volume, biomass, carbon storage)	land/forest ownership, origin, age class, diameter class, tree species (group) structure, forest stratum structure, community structure	DBH, average tree height, canopy density, density, humus thickness, thickness of dead branches and fallen leaves, wind protection and sand fixation amount, dust retention amount, number of atmospheric pollutants absorbed, oxygen release amount	forest health condition, forest disaster condition, forest carbon sink, water source conservation index
Grassland	grassland type, vegetation type, dominant species	grassland area, grass yield, carbon storage	land ownership, vegetation structure, origin	area affected by biological disasters, soil conservation amount, wind protection and sand fixation amount, oxygen release amount	grassland carbon sink, health grade, grass-livestock balance index, water source conservation index, conservation of genetic resources
Wetland	wetland type, vegetation type, wetland grade	wetland area, vegetation cover area, biomass, carbon storage	land ownership, origin of vegetation	DO, soil moisture content, flood storage capacity, water quality purification volume	wetland carbon sink, health grade, state of threat, wetland protection rate, water source conservation index
Water	water body type	water area, groundwater level, flow velocity, flow rate	mode of utilization, ecological water consumption	electrical conductivity, pH, temperature, chlorophyll a, total nitrogen, total phosphorus, COD, eight major ions (K+, Na+, Ca2+, Mg2+, Cl-, SO42-, HCO3-, CO32-), alkalinity, fluoride, mineralization level, fluoride, mineralization level	water quality grade, carbon sink, state of threat, water source conservation index
Minerals	genetic type	number of mining areas, number of mineral deposits, reserves, resource quantity	utilization dynamics, type of exploration, degree of exploration	main components and quality indicators of the ore, grade, beneficiation performance, scale, geological conditions of the ore deposit, minability, selectivity, economic feasibility availability for use, restrictive conditions	resource and environmental impact assessment

Table 1. Preliminary Design of Comprehensive Survey Elements and Indicators for Natural Resources

4.5 Field Survey

According to natural resource survey indicators and technical requirements, a comprehensive field survey of natural resources can be carried out, which can be divided into surveys such as type, quantity, quality, structure, and function. The investigation of the types and quantities of natural resources is based on the results of the "3rd National Land Resource Survey", high-resolution and aerospace remote sensing images, and special survey data of natural resources. Through internal analysis and judgment, natural resource patch categories and boundaries are verified one by one to determine their natural resource categories and boundary ranges. The investigation of the quality, structure, and function of natural resources integrates and inherits special survey results and thematic attribute data of natural resources through technical means such as spatial linkage and supplements the current and high-quality thematic attribute information into the basic survey results. For natural resource patches with low or no spatial overlap that cannot inherit thematic attribute data through technical means such as spatial hooking, a supplementary survey of relevant thematic attributes should be conducted by combining internal and external work.

According to the indicators for investigating natural resource elements, the technical methods of the survey are also different. We summarize and organize the available technical methods for investigating seven natural resource elements, including land (cultivated land), ground substrates, forests, grasslands, wetlands, water, and minerals.

4.6 Software Development

According to the construction and quality requirements of the three-dimensional spatiotemporal database of natural resources, based on the background results of the comprehensive survey of natural resources, the integration of natural resource management data, the use of the three-dimensional spatial position as the basic link to organize and connect all natural resource bodies, the use of the basic surveying and mapping results as the framework, digital elevation models as the foundation, high-resolution remote sensing images as the background, and the use of the three-dimensional spatial position, a complete set of images is established; a comprehensive survey database of natural resources that integrates photos, types, scope, and attributes is constructed; a three-dimensional spatial model of natural resources is constructed; spatial correlations between aboveground and underground natural resources and management data are established; a comprehensive survey and management system for natural resources are constructed; rapid queries, statistical summaries, and the sharing of natural resource achievements are achieved; and systematic support for the comprehensive management of natural resources is provided.

4.7 Analysis and evaluation

Comprehensive analysis and evaluation include background analysis, state assessment, and trend prediction of natural resources.

(1) Background analysis is a spatiotemporal statistical analysis of the basic data of each natural resource element, reflecting the historical and current information of natural resources from three aspects: Quantity, distribution, and structure. Background analysis is a direct and objective representation of the basic data of China's natural resources.

(2) State assessment is the process of revealing the endowment characteristics, resource carrying capacity, and utilization potential of natural resources at a certain temporal, spatial, or thematic scale from the perspectives of the distribution pattern, change process, and quality/ecological dynamic characteristics of natural resources.

(3) Trend prediction, from the perspective of earth system science, aims to deepen the study of the interaction and mutual feedback mechanisms of different natural resources; clarify the coupling relationships among mountains, rivers, forests, fields, lakes, grasslands, sand mines, etc.; explore the interaction and mutual feedback mechanisms of different types of natural resources; predict evolutionary trends; evaluate carbon sink potential; support and serve natural resource management, national spatial planning, ecological protection and restoration; and meet the "dual carbon" strategic goals.

5. Discussion

The comprehensive investigation of natural resources is a large systematic engineering project that horizontally realizes the investigation of mountains, rivers, forests, fields, lakes, grasslands, and sands. Vertically, this study clarified the support and breeding relationships among the surface substrate layer, surface cover layer, and the protection and utilization of natural resources and national land space. Moreover, it can achieve integration, visualization, and three-dimensions on the data platform and can clearly visualize the "three-dimensional integrated" images of each resource, knowing its location, area, quality, and evolutionary trend. The distribution, structure, and impact relationships of comprehensive resources can be clarified by turning dull data into freely accessible maps and images, ensuring that comprehensive investigations are greater than the "3rd National Land Resource Survey".

The National Resources Comprehensive Survey Command Center of the China Geological Survey has deployed pilot projects for comprehensive natural resource multiple element surveys in more than ten typical areas, including the five national ecological civilization experimental zones of Hainan, Fujian, Chengde, Yichang, and Guang'an, as well as the Danjiangkou Zhongxiang section of the Han River Basin. These projects have laid a solid foundation for the construction of the next national land natural resources comprehensive survey technology system. However, there is a gap between the goal of upgrading the "3rd National Land Resource Survey" to the "1st Comprehensive Natural Resource Survey".

6. Conclusions

We believe that the focus should be on actively and steadily advancing future work in the following aspects:

(1) The formulation of standards and norms for the comprehensive investigation and monitoring of natural resources should be accelerated. On the basis of relevant standards and norms, and in accordance with the principles of "continuity, stability, transformation, and innovation", a series of standards and norms for the comprehensive investigation of natural resources are scientifically constructed, including comprehensive investigation content and indicators, data regulations and collection requirements, basic statistical techniques, field investigation techniques, quality evaluation, and result data collection, to provide guidance for the process of comprehensive natural investigation and to ensure the

availability, reliability, safety, and maintainability of comprehensive survey data.

(2) To carry out typical application demonstrations, explore and lead the direction of comprehensive investigations. There are various elements and survey indicators in comprehensive surveys of natural resources, with large time spans and spacial scales, involving knowledge from multiple disciplines and professional fields. In addition to standards and norms, technical connections, methods and evaluation systems need to be deeply explored and constructed. Thus, it is necessary to carry out application demonstrations at different scales and element types, break through the major technologies of efficient three-dimensional connections between space, sky, earth, and well, and gradually construct a comprehensive survey, monitoring, analysis, and evaluation system for natural resources under the guidance of earth system science, beginning from diversified application service needs.

(3) We need to establish and improve a comprehensive investigation mechanism and investigation team as soon as possible. The comprehensive investigation of natural resources is a large systematic project with wide coverage, great differences in factor indicators, and high difficulty in technical collaboration. It is necessary to draw on the experience of national special investigations and to innovate organizational models and approaches from multiple aspects, such as funding, technical strength, and data quality. Furthermore, a comprehensive force with strong technical strength, excellent quality management, and rich investigation experience must be built. According to the principle of "adjusting forests, grass, and water when encountering forests...", the survey should be conducted to collect as much data as possible from field work, achieving a comprehensive investigation with multiple uses.

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