Development of Internet Plus Smart Environmental Protection

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Abstract: Internet Plus Smart Environmental Protection integrates Internet innovations with ecological environment protection and promotes technological progress in the conservation field. It also promotes decision-making, supervision, and public service levels of ecological environmental protection, and accelerates the transformation of the environmental management mode. This study analyzes the demand for Internet Plus Smart Environmental Protection, summarizes the technical status in terms of ecological environment information collection, transmission, management, and decision-making, and identifies the problems concerning its development. An overall framework of Internet Plus Smart Environmental Protection is also proposed, and four typical application fields are studied: precise air pollution control, systematic water pollution treatment, ecological surveillance, and resource trading. To promote Internet Plus Smart Environmental Protection, it is necessary to develop multisource ecological monitoring, deep data analysis, and multi-business co-modeling, as well as advance policies that encourage data sharing concerning environmental protection, and foster new businesses represented by environmental information services.

Keywords: Internet Plus; smart environmental protection; direction of application; environmental information service

1 Introduction

In the new round of global scientific and technological revolution and industrial transformation, the integration and development of the Internet and other related subjects have significant prospects and have become the trend of the times. Internet Plus is the integration of the Internet's innovative achievements with all sectors of the economy and society, forming a new kind of economic and social development based on its infrastructure and innovation elements. The Internet Plus action plan has the potential to promote technological progress, efficiency improvement, and organizational change, and enhance the innovation and productivity of the real economy.

Internet Plus is highly valued in China. The *Guiding Opinion of the State Council on Actively Promoting the Internet Plus Action Plan* has made clear 11 key actions to promote Internet Plus [1]. In the Internet Plus green ecological action, we need to promote the deep integration of the Internet and ecological civilization, improve the monitoring and information release system, and form a dynamic monitoring network covering the main ecological elements. It also makes specific deployment on how to play the Internet's role as a platform in the reverse logistics recycling system and promote the convenience, interaction, and transparency of the transaction and utilization of renewable resources [2]. The Ministry of Ecology and Environment puts forward the overall plan of ecological environment big data construction [3], using modern information technology (IT) means such as big data and cloud computing to improve the comprehensive decision-making, regulatory governance, and public service level of

ecological and environmental protection, and change the mode of environmental management and work.

The application of the new generation of mobile Internet has brought rapid changes. There is emergence of the application of artificial intelligence (AI) in environmental protection. Constant innovation is happening in the development of technology, such as blockchain and edge computing. The new technology is a key support for promoting the development of Internet Plus smart environmental protection. With the implementation of a series of major environmental projects from the 11th Five-Year Plan to the 13th, the Internet Plus smart environmental protection has made remarkable progress in related technologies, industries, applications, policies, and security levels, laying a solid foundation for promoting the historical transformation of environmental protection. We should also note that in the process of integration and development of Internet Plus smart environmental protection, there are still some problems to be solved, such as data sharing, business collaboration, and market application. Focusing on them, this paper discusses the development needs, technology and application status, problems, countermeasures, and suggestions, to provide a reference for the research and application of Internet Plus smart environmental protection.

2 The development needs of Internet Plus smart environmental protection

With the continuous deepening of the environmental governance system reform, the combination of the Internet and environmental protection can regulate the resources and the power of the government, enterprises, and the public, and realize a collaborative and innovative environment governance. Internet Plus smart environmental protection adopts technologies such as the Internet, cloud computing, big data, and the Internet of Things, and promotes the opening and sharing of data related to pollution source supervision, environmental quality monitoring, environmental governance, and industrial environment to form a closed-loop source control, process supervision, comprehensive governance, and people-to-governance environmental management; and all these on the basis of the construction of a full-time spatial network for environmental monitoring. It then gets a comprehensive eco-environmental decision-making ability and precise supervision, offers convenient public service, helps improve environmental quality and prevent environmental risks, and provides people with better ecological products.

Internet Plus smart environmental protection has real market demand and good growth potential. With the deepening of the application of the Internet in environmental protection, future needs will become more comprehensive: environmental protection intelligence requires efficient and accurate monitoring and analysis technologies and a technology ecosystem that is organically integrated with Internet Plus; there is an urgent need to ensure all-round integration of the Internet and the environmental protection industry, including improving existing technical routes, business models, and management methods; the environmental monitoring industry has major development opportunities, involving smart monitoring of air, soil, and water [4]; demand for relevant implementation and operation, and maintenance services have also become the focus, as well as relying on Internet Plus to realize intelligent real-time dynamic monitoring and maintenance services, to improve the efficiency of smart environmental protection applications, and to minimize costs and uncertain interference factors [5].

3 The Technology and application status of Internet Plus smart environmental protection

3.1 Collection and transmission of ecological and environmental information

In recent years, the ecological environment information collection capabilities of China have made great progress with the gradual construction of the environmental monitoring system: multiple monitoring techniques such as biological, physical, ecological, and satellite remote sensing monitoring have been put into use, and the space/air/ground integration tridimensional monitoring system has been completed; new monitoring equipment such as environmental monitoring microstations, exhaust gas telemetry, lidar, and high-definition video have been deployed on a large scale, since the monitoring accuracy has been greatly improved. For example, in terms of atmospheric environment monitoring, the space/air/ground integrated ecological environment tridimensional monitoring system has realized satellite remote sensing air pollution concentration monitoring, drone aerial remote sensing air pollutant concentration monitoring, and micro air substation pollutant concentration monitoring;. Compared with conventional air quality monitoring stations, it has comprehensively improved the multi-temporal, multi-dimensional perception, and real-time monitoring capabilities of air pollution [6].

Based on the perception system of the Internet of Things, the comprehensive perception of various environmental elements such as water, air, soil and ecology, has seen status quo assessment of the ecological environment quality

and the prediction of the trend of changes to a certain extent, thereby scientifically warning of possible environmental pollution accidents. It initially realized the transition from extensive supervision to a refined one. The ability to monitor pollution sources and end-of-pollutant discharges and working conditions has taken shape. The environmental protection management model has shifted from post-treatment to pre-prevention. The supervision of transportation of hazardous wastes and chemicals prevents environmental risks, enables quick and efficient response to sudden and major pollution incidents, and ensures joint prevention and control.

The application of technologies such as tridimensional comprehensive monitoring of the ecological environment, data fusion, and fifth-generation mobile communication (5G) in the Internet Plus smart environmental protection system still needs to be deepened. Future development will be in two areas: (1) Application of multisource ecological environmental monitoring technology to collect information, integrates data resources, establishes a monitoring data system with temporal and spatial integrity, and select technologies with great value after verifying technical feasibility, economics, and science. (2) By using efficient data transmission technology represented by 5G to improve the supervision system to realize three-dimensional, all-round monitoring and real-time and efficient data transmission. The relevant ecological environmental sensing equipment covers standard monitoring stations, micro/small monitoring stations, remote sensing satellites, unmanned aerial vehicles, and unmanned ships.

3.2 Ecological and environmental management and decision support

The ecological environment management department sets up a business application system, after getting the requirements of a proprietary business, through the optimization and coordination of business management processes, and significantly improving work efficiency. These include construction project management, environmental statistical information, pollution charges, pollution declaration and registration, biodiversity management, environmental quality management, pollution source management, nuclear and radiation management, satellite environmental remote sensing applications, and ambient air quality prediction and forecasting systems. The overall level of development and utilization of environmental information resources is relatively high, and information products such as environmental quality bulletins, environmental statistical annual reports, air quality daily reports, water quality monitoring weekly reports, and satellite remote sensing monitoring briefings are regularly released, providing an important base for environmental protection.

As the pollution source management model shifts from decentralized and segmented management to comprehensive management that embodies elements, the establishment of a professional ecological environment management platform that reflects the characteristics of core environmental elements such as atmosphere, water, and natural ecology has emerged as the development direction and application trend of smart environmental protection [7]. The technical requirements for adapting to ecological environment management and decision-making support are multiple. They include using big data information management technology to carry out data collection and integration, using comprehensive environmental simulation and multi-business collaborative modeling technology to predict future scenarios, applying cloud computing technology to improve forecasting efficiency, adopting AI technology to comprehensively analyze and process multisource data, issuing early warning and disposal information to achieve emergency warning and rapid traceability, and realizing intelligent management of environmental risks through sensing equipment and public feedback.

Scientific top-level design is a key prerequisite for the implementation of Internet Plus smart environmental protection applications. It includes designing the corresponding overall technical architecture from a global perspective, and considering all aspects, levels, service objects, and factors involved in the architecture. According to the unified planning, platform, standards, security levels, and operation and maintenance norms, the construction of environmental protection informatization can be promoted by sorting out the business process of environmental management, analyzing the needs of informatization construction system, and designing its forward-looking overall framework. The problems related to the difficulties of sharing resources and information interconnection between institutions and departments can be alleviated by taking some practical measures, and paving the way for the implementation of the plan. By combining some technologies such as cloud computing, big data, and AI, the evaluation and prediction of the ecological environment can be realized, with transformation from monitoring to supervision both automatically and intelligently.

4 Problems faced by Internet Plus smart environmental protection

Since the 11th Five-Year Plan period, the construction and implementation of a series of major environmental protection projects have seen outstanding achievements; the development of the Internet Plus smart environmental

protection has laid a good foundation for the historic transformation of environmental protection. It should also be noted that in the process of integrating Internet Plus with smart environmental protection, there are still some problems to be solved in terms of technology, industry, and application.

4.1 The technical level

Promoting the deep integration of Internet technology and smart environmental protection is the technological basis for the innovative development of smart environmental protection. However, the innovative application of relevant new technologies does not match the rapid development pace of the environmental protection business. Domestic enterprises and institutions urgently need to strengthen technology research and development and innovative application of environmental monitoring and intelligent governance facilities, so as to effectively alleviate the problem of the introduction of some foreign advanced environmental protection technology. The integration of Big data, 5G, and AI technology with the Internet Plus smart green application is still inadequate, especially the in-depth application of comprehensive decision-making services, which need to be strengthened. In addition, efforts should be made to promote the openness of environmental protection information and resources, the in-depth development and utilization of data, and the innovation of environmental protection service models through scientific research, demonstration, practice, and other measures.

4.2 The application level

Considering the practical needs of environmental management, environmental protection authorities have set up business application systems, which have improved the development and utilization level of environmental information resources in China. China is still in its infancy in terms of the innovation application system focusing on Internet Plus smart environmental protection, especially with the absence of key contents such as the top design, cooperation pattern, and cross-border integration core standards guide for the Internet Plus smart environmental protection, which blocks the application scope and strength of relevant technologies.

4.3 The industrial level

China has a strong demand for environmental improvement and a large-scale environmental protection market. The industry has the business capabilities represented by advanced dust removal and desulfurization, domestic sewage treatment, residual heat and pressure utilization, and green lighting equipment supply. However, there are vulnerable areas in the environmental protection industry: (1) The slow promotion of excellent environmental protection technology in the domestic market caused by disordered market competition, coupled with insufficient integration of environmental protection and the Internet, and serious information asymmetry, results in the supply capacity of the environmental protection industry being far from meeting the requirements of ecological civilization, construction, and market demand; (2) Lack of a comprehensive environmental protection service platform that is authoritative, internationalized, and widely recognized by the government and the market. Many local governments and pollution-generating enterprises lack information channels to obtain applicable environmental protection technologies, which leads to difficulties in technology supply and demand docking; (3) The development of an environmental technology innovation system with enterprises as the main body is slow. New technology demonstration and promotion channels are not smooth, and the development of the environmental service industry is relatively backward.

5 The framework and typical application of Internet Plus smart environmental protection system

5.1 The general framework

Considering the law of activities in the whole lifecycle of environmental protection and the standards and norms, safety management, operation and maintenance management requirements of Internet Plus smart environmental protection construction, an architecture is proposed (Fig. 1). This framework includes the following four aspects:
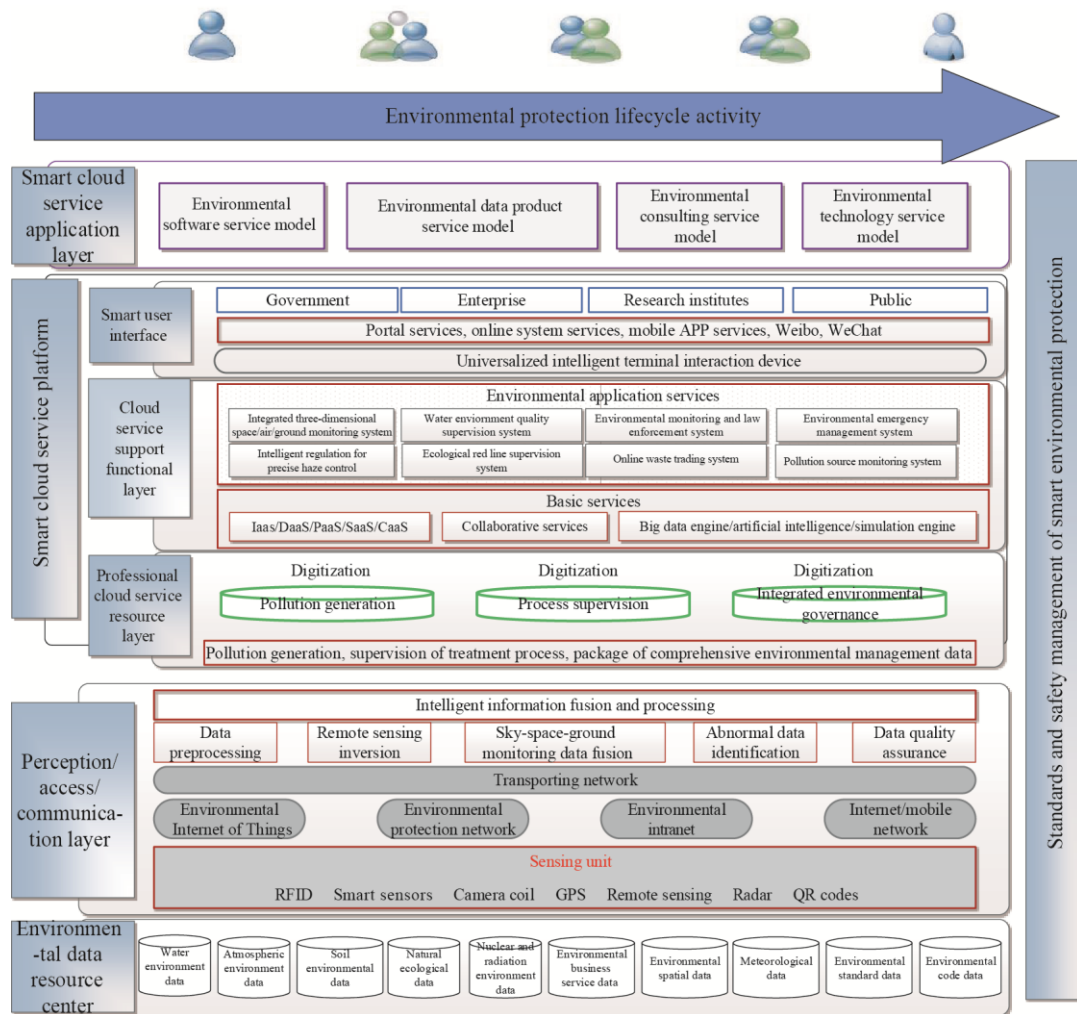
Fig. 1. The architecture diagram of Internet Plus smart environmental protection system.

Environmental data resource center collects resources of Internet Plus smart environmental protection and provides support for business applications. Environmental management involves complex business and diverse data types (multi-dimension, multi-scale, and wide-ranging). At the data level, it is divided according to the subject to form respective databases.

The perception/access/communication layer is used for the perception, transmission, and processing of data, obtaining it through sensors, cameras, radars, and other sensing units, and transmitting data through environmental protection Internet of Things, private network, Intranet, Internet, mobile and other networks. After data preprocessing, data fusion, abnormal data identification, data quality assurance, and other processing steps, the fusion of intelligent information can be achieved.

The intelligent and environmental cloud service platform layer is divided into three categories: (1) Professional cloud service resource layer is used to encapsulate the data of pollution generation, processing process supervision, comprehensive environmental governance, and other aspects; (2) The cloud service support layer covers basic services such as big data engine, AI and collaborative services, as well as environmental application services such as integrated three-dimensional space/air/ground monitoring, intelligent regulation for precise haze control, water environment quality supervision, ecological red line supervision, and online waste trading; (3) Intelligent user interface includes government, enterprises, research institutes, the public and other different user types as well as portal sites, online systems, applications, and other terminal interactive devices.

Intelligent cloud service application layer is used to classify Internet Plus smart environmental protection service mode, generally divided into environmental protection software service mode, environmental protection data product service pattern, environmental protection consulting service pattern, and environmental protection technology service pattern.

5.2 Typical application directions

5.2.1 Application in precise air pollution control

The application and exploration of Internet Plus smart environmental protection in the prevention and control of air pollution is of scientific significance and practical value in promoting precise and systematic governance and continuous improvement of the atmospheric environment. Domestic enterprises have the basic capability of comprehensive air pollution prevention and control services, and the relevant market size is about several billion CNY. (1) A three-dimensional monitoring system has been established, and advanced monitoring technologies such as satellite remote sensing, high-altitude video, unmanned aerial vehicles, grid-based monitoring microstations, lidar, and online monitoring equipment for pollution sources have been integrated to collect air quality and pollution source data. (2) The implementation of precision research and judgment, through environmental big data analysis and impression, scenario simulation and other multiple models, catching the sticking point of pollution and rapid diagnosis of pollution emission trend, is in line with the dynamic regulation requirements of air quality. (3) The proposal of targeted control suggestions, combined with the experience of the expert team on pollution control, carried out scientific standard analysis. It plays an important role in long-term targeted pollution control, and also has emergency precision control ability. (4) We will carry out scientific assessment of the effectiveness of pollution prevention and control, and provide targeted assessment services on the effectiveness and performance of regional pollution prevention and control in accordance with various prevention and control, and regulatory measures.

A set of air pollution prevention and control business processes featuring "three-dimensional monitoring, precise research and judgment, targeted management and control, and scientific assessment" are established on the basis of three-dimensional monitoring, air–space–ground integration, and environmental big data analysis. An expert team's experience will be highlighted to support the construction of a working model of precise air pollution prevention and control; intelligent control and scientific evaluation; and the preliminary realization of scientific, refined, and economic air pollution prevention and control [8].

5.2.2 Application of systematic water pollution control

For the prevention and control of water pollution, the role of Internet Plus in smart environmental protection is reflected in smart supervision and targeted governance. After the adjustment of the management functions of state institutions, the sewage outlets will be integrated into the ecological and environmental management system. The intelligent supervision system of the water control one has information-based supervision capability of the whole chain of "pollution source–drainage–water body," so as to realize the unified supervision of water pollution source, flow, and sink. On the basis of a general survey and detailed investigation of pollution sources and sewage outlet, the dynamic database support system was established and applied. In addition, the refined management of water environment science focuses on reflecting the topological relation of pollutant discharge outlets, grasping the quantitative relation of pollution generation—discharge—entering rivers or lakes, and the response relation of discharge flux into them, and cross-section water quality. It focuses on the construction of business application subsystems such as pollution source supervision, water quality monitoring, law enforcement supervision, and river length system platform, so as to comprehensively grasp the water environment and relevant information and have the ability to respond quickly to pollution incidents.

Another important aspect of systematic water control is the engineering treatment of water environment. As an important part of water environment quality assurance, the construction and operation of relevant engineering facilities embody the concept of targeted engineering management system through integrated design and optimization, so as to ensure the accessibility of water quality objectives. The application of Internet Plus smart environmental protection in this direction, such as the coordinated operation and control decision of ecological water replenishment and pollution treatment facilities, has effectively promoted the overall optimization of project scheduling and the play of energy efficiency.

5.2.3 Application of ecological regulation

The application of Internet Plus smart environmental protection in the field of ecological regulation includes the regulation of ecological red line, nature reserves, and biodiversity. By comprehensively utilizing satellite remote sensing, cloud computing, and geographic information system, a multi-scale/multi-temporal, space/air/ground integrated ecological regulatory information database will be established. Relying on the UAV remote sensing with ground ecological observation ability of fast access to data, to carry out business application in the fields of ecological protection red line patrol, human activity monitoring, ecological system pattern, ecological system quality,

ecological risk supervision, ecological protection, ecological asset statistics accounting effectiveness evaluation, mobile inspection, and law enforcement, the level of national ecological supervision has been enhanced.

As an important part of China's "three lines and one list" (i.e., ecological protection redline, environment quality baseline, resource utilization upper line, and ecological environment access list) environmental management mode, the ecological red line is an important direction for the construction of an ecological supervision system in the future. Internet Plus smart environmental protection has great application prospects in the field of ecological supervision. It combines the demarcation of ecological red lines with the approval of construction projects, planning, and environmental assessments as well as other business approvals. The achievements of red line protection were scientifically evaluated from the dimensions of human activity disturbance and ecological environment quality. For example, the Satellite Environmental Application Center of the Ministry of Ecology and Environment applied a variety of operational systems, which indicates that the construction of ecological supervision system based on satellite remote sensing has achieved phased results.

5.2.4 Application in resources trading

The comprehensive integration of the environmental protection industry and Internet technology has promoted the deepening application of Internet Plus in the field of environmental protection, and industries such as online waste trading, online connection of environmental protection technologies, and online trading of enterprises' pollution emission rights have emerged. The development of these environmental formats needs to optimize the technological route, business model, and management mode, so as to promote the industrial technological progress and the subversive reform of the environmental protection industry.

We will further encourage Internet enterprises to participate in the construction of urban waste recycling platforms and promote innovation in renewable resource recycling mode. We will use Internet of Things technologies such as electronic tags and two-dimensional codes to track the flow of key electronic waste and implement the construction of waste information platforms in various industrial parks. We will promote the transformation and upgrading of the existing backbone renewable resource trading market toward an online and offline combination, and gradually form an online trading system for industrial waste and renewable resources in the industrial and regional sectors. We will focus on reducing total emissions of major pollutants and explore pilot projects for enterprises to trade their emission rights online. A pilot carbon emission trading market will also be launched, and we will promote the online display and promotion of enterprises' achievements in energy conservation and low-carbon experience through the circular economy information exchange platform. Through the promotion of the demonstration project, the full implementation of the waste online transaction process will be accelerated.

6 Countermeasures and suggestions

6.1 The level of technology

We will develop multisource ecological environment monitoring technologies, paying attention to their feasibility, economy, and scientificity, and select applications with outstanding practical value to ensure the in-depth development of Internet Plus smart environmental protection. We will integrate the technological achievements of the Internet, the Internet of Things, mobile communications, and cloud computing among others into the ecological and environmental regulatory system to promote the overall improvement of the efficiency of information collection, transmission, and processing. It highlights the business demand orientation of ecological and environmental management, optimizes the top-level design of relevant systems, and adopts big data technology to efficiently implement data collection and integration. The integrated environment simulation, multi-service collaborative modeling, and other technologies are used to reasonably predict future scenarios, and AI technology is used to assist the comprehensive analysis and processing of multisource data to support the management decision of an ecological environment.

6.2 The level of application

We will step up efforts to promote open and shared data policies and ensure that Internet Plus smart environmental protection plays its role in environmental management and decision-making. Defining the specific responsibilities of the competent department and relevant units, the latter's main responsibilities should be especially strengthened. Meanwhile, the data producers and users are approached with clear and well-defined requirements, combined with the actual situation to update. The exchange and use of data shall be reasonably supervised, and the competent authorities and relevant units shall specify the data confidentiality level and the conditions for data opening in

accordance with the law. The respect for data production reflects in paying attention to it and standardizing the behavior of data users. We should pay attention to data accumulation and promote open sharing. Data generated by environmental protection informatization projects should be collected and exchanged compulsively, and the data center should be used for standardized management and long-term preservation. The data management capacity building should be strengthened and relevant stakeholders must establish a specific working and incentive mechanism with clear assessment responsibility.

6.3 The level of industry

We will further promote Internet Plus smart environmental protection, and fully empower the chain development of the environmental protection industry, its technological upgrading and reform, and the expansion of the scale and competitiveness of environmental protection enterprises. Environmental enterprises will increase investment in smart environmental protection and plan the transformation and upgrading of the sector. Key breakthroughs will be made in the policy system of the industry and the standardization of the environmental service industry, so as to standardize and guide technical planning, financial support, and talent cultivation. The objective is also to rationally support the environmental protection industry and promote the standardization and large-scale development of the environmental information service industry as a new feature.

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