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Adaptative Strategy of Powerful Country of Science and Technology for Modernization of China's Space Governance

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Abstract
As an important field in the construction of ecological civilization, spatial governance is a relatively weak field in China's governance system. In the past 40 years of rapid economic development, unbalanced regional development, disharmony between nature and society, and disordered spatial structure have become prominent problems. In the support of space governance, science and technology have problems such as the division of natural sciences and social sciences, the imperfect data co-construction and sharing mechanism, and the disconnection of scientific research and decision-making management, which seriously hinders the need for the modernization of governance systems. The formation of an adapting strategy for the modernization of China's space governance by a technologically powerful country is of great significance for China to realize the transition from a well-off society to a modern society, and for China to improve its level in the global governance system. On the basis of discussing the complexity of space governance objects, the scientization of government decision-making and management, and the general trend of science and technology serving social development, this study proposes a new framework of science and technology innovation oriented to space governance, which is dominated by theoretical innovation, data construction, and knowledge application. Combined with the analysis of innovative key scientific issues, focusing on the needs of the whole process of territorial planning with determining the planning objectives, applying analytical methods, developing layout plans, improving the control system, supporting safeguard measures, implementing dynamic management, etc., this study systematically discusses the two major issues of developing a unified geographic theory system and data foundation. Among them, the main points of the theoretical system include: the comprehensive equilibrium theory of space, the coupling mechanism of natural and social systems, the evolution law of regional function-spatial structure, the spatial interaction relationship, the spatial governance mechanism, and the reverse decoupling principle of geographical process-geographical pattern.

Keywords
spatial governance; sustainability; human-nature coupling; spatial planning; unified geography

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Adaptative Strategy of Powerful Country of Science and Technology for Modernization of China’s Space Governance

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Abstract: As an important field in the construction of ecological civilization, spatial governance is a weak link in China’s governance system. In the past 40 years of rapid economic development, unbalanced regional development, disharmony between nature and society, and disordered spatial structure have emerged. In the support of space governance, science and technology have problems such as the division of natural sciences and social sciences, the imperfect data co-construction and sharing mechanism, and the disconnection of scientific research and decision-making management, which seriously hinders the modernization of governance systems. The formation of an adapting strategy for the modernization of China’s space governance is of great significance for China to realize the transition from a moderately prosperous society to a modern society, and to improve the global governance system. Considering the complexity of space governance objects, the scientization of government decision-making and management, and the general trend of science and technology serving social development, this study proposes a new framework of science and technology innovation oriented to space governance, which is dominated by theoretical innovation, data construction, and knowledge application. Considering the whole process and key demands of national land space planning, this study systematically discusses the two major issues of developing a unified geographic theory system and data foundation from the aspects of planning goal, analytical methods, layout plans, control system optimization, safeguard measures and dynamic management. The main points of the theory system include the comprehensive equilibrium theory of space, the coupling mechanism of natural and social systems, the evolution law of regional function-spatial structure, the spatial interaction relationship, the spatial governance mechanism, and the reverse decoupling principle of geographical process-geographical pattern.

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Global change and globalization are deeply altering the earth where we survive and develop. How should human beings adapt to the changes in the natural environment? How should human society respond to economic globalization? Reformation and improvement of global governance system have gradually become a common problem for the scientists of all countries in the development of the community with a shared future for mankind instead of just a concern of politicians. In particular, facing the COVID-19 pandemic, countries of different political systems, physical geographic environments, cultural backgrounds and development patterns adopted different strategies, with different costs of life. At the post-disaster adaptation stage, the economic resilience, social trust and even the review of relationship between human and nature will vary in different countries and regions, which will reshape people’s environmental ethics and development values, economic benefits and even core competitiveness, political system advantages and governance capacity. This will affect the scientific and technological innovation, natural environment, human resources, and social wealth for future survival and development in various countries and regions. Correspondingly, the powers of science and technology will face a series of new propositions\textsuperscript{[1–3]}. How a differentiated governance system in regional space rapidly, efficiently and precisely adapts to global changes and different national conditions is undoubtedly a highly complex issue which is bound to be associated with comprehensive scientific problems. The addressing of this problem determines, to a large extent, the reordering of countries in comprehensive competitiveness. Therefore, the adaptive strategy for the modernization of space governance of China as a science and technology power is of great strategic significance and scientific value.
1 Demand for and weakness of science and technology in space governance

The Commission on Global Governance made a standard definition that “governance is the sum of many ways individuals and institutions manage their common affairs,” which is representative and authoritative in modern public administration \([4]\). According to the system characteristics and the requirement of space as the governance object, the government is the subject for the space governance of China. That is, space governance is the process of implementing system and mechanism and using policies to rationalize space layout and order space structure, thus improving the condition, efficiency and competitiveness of the national land space.

Space governance received little attention in the previous economic and social development of China. During the planned economy period, particular emphasis has been placed on the overall balance of economic sectors, industry and products. Since the reform and opening up, promoting economic development at the expense of national land space resources and environment has been the dominant mode over a long period of time, which has caused space imbalance, a problem needed to be solved for high-quality development in the future. Accordingly, the relatively backward space governance capacity has become a weakness for the improvement of governance capacity and the modernization of governance system in China \([5]\). At present, the CPC Central Committee has determined building a Beautiful China as the goal of the construction of ecological civilization, the carrier of which is national land space. Therefore, the modernization progress of space governance determines the advancement of modernization in all respects, both goal oriented and problem oriented. Even for various subjects of space governance, enhancing the support capacity and application of science and technology will be essential for the modernization of space governance.

1.1 Strong dependence of major practical demands on and weakness of science and technology

In the modernization of China, the combination of decision-making and science, especially the dependence of decision-making on science, has been a poor link over a long period of time. Many inappropriate vital decisions are caused by the lack of scientific verification, neglect of scientific laws, and scientific workers’ failure to get involved in the decision-making process.

However, the post-disaster reconstruction of Wenchuan Earthquake in 2008 was quite another thing. It was planned on the basis of basic evaluation and guided by the plan, displaying the advantages of the socialist system with Chinese characteristics in an all-round way and an entire chain. After the earthquake, the government was faced with the dilemma of localized or relocalized reconstruction as well as a series of major decision-making problems such as the selection of site and scale for post-disaster reconstruction, which relied on the scientific research and verification. In the complex global environment of that time, the successful reconstruction of Wenchuan was mainly attributed to the scientificity of the decision-making process and solution. Specifically, modern technologies such as remote sensing were employed to accurately depict disaster damage; resource and environment carrying capacity for reconstruction was evaluated; regionalization of main function was schemed on the basis of the scientifically verified plan; the reconstruction of villages and towns followed the blueprint of the planners; the post-disaster reconstruction system including natural environment restoration and psychological assistance was improved \([6]\). Wenchuan reconstruction has not only been highly appreciated by the international community, but also set up a standard for China to deal with major disasters in the future. More importantly, the evaluation of resource and environment carrying capacity determined has become the basic work of China’s sustainable development decision, which reflects the dependence of the construction of ecological civilization on the scientific research and verification, thereby influencing the modernization of China’s governance system.

In the deployment of Wenchuan reconstruction by the CPC Central Committee and the State Council, the evaluation of resource and environment carrying capacity, as the basis of reconstruction planning, was conducted under the leadership of the Chinese Academy of Sciences. When the major demands are directly considered as the work and responsibilities of scientists, the mismatch between the science and technology support capacity and the major national demands will become a serious problem, which is one of the weaknesses in the building of a science and technology power. Many problems appear in the evaluation of resource and environment carrying capacity in Wenchuan reconstruction and should be emphasized in the space governance modernization of a science and technology power.

(1) The basic data of human settlement and activity space are seriously deficient. The space data of western China are insufficient, and there are even no vectorized data on the administrative boundaries of some villages and towns. The basic data of the exploitation and utilization of the nature by human activities are insufficient, as manifested by the low-precision data of mountainous areas in engineering geological maps and hydrogeological maps. The socioeconomic statistical data and natural data are separate. The data of the space distribution of human activities (e.g., population size) are not spatially coupled with the data of natural disaster risks in landslide and debris flow areas.

(2) The technical methods such as the numerical simulation and physical simulation of basic process and uncertainty are defective. The sites for post-disaster reconstruction involve temporary and permanent resettlement areas, and the
latter can be selected inside and outside the disaster area. The uncertainties, such as the risks of barrier lake and secondary disaster, impact the site selection inside the disaster area. In the case of a certain investment scale and changing migration intention, the space arrangement upon the reconstruction will become the optimization of the dynamic system. Both the numerical simulation of the whole and the physical simulation of uncertainties in response to the major security emergencies are basically blank. For example, there are large errors between the data acquired by modern remote sensing technology and the real data obtained by field inspection when the vegetation damage and building damage are not significantly displaced and deformed.

1.2 Misleading of the weakness of science and technology in the strong dependence

Despite the obvious weaknesses, science and technology still played an irreplaceable role in supporting Wenchuan reconstruction, which reflected strong dependence of the construction of ecological civilization, especially the modernization of space governance system, on science and technology. In the documents released by the Central Committee of the CPC in recent years, such as *Opinions on Improving the Strategy and System of Development Priority Zones (ZF [2017] No. 27)*, *Opinions on Establishing a Long-Term Mechanism for Monitoring and Early Warning of Resource and Environment Carrying Capacity (TZ [2017] No. 25)* and *Provincial-Level Pilot Program for Space Planning (TZ [2016] No. 51)*, the application of science and technology methods is mentioned in a large number of paragraphs. In the decision-making and management of macro and strategic fields, the Central Committee of the CPC depends more on science and technology support than ever for the construction of ecological civilization, especially the formation of the system for developing and protecting the national land space. In turn, to achieve the goal of the Beautiful China, we must insist on the construction of a science and technology power, since the national land space is the carrier of the Beautiful China.

It is an urgent problem to overcome the weaknesses of science and technology, especially those in the fields where the major national decisions and strategic actions are seriously misled, to build a science and technology power. Regionalization of development priority zones is an important strategy and a basic system for optimizing the national land space pattern, which can be realized on the basis of the determination of three regional functions: ecological security, food security and urbanization. In November 2019, the General Office of the CPC Central Committee and the General Office of the State Council released the *Guidance on the Overall Delineation and Implementation of Three Control Lines in the National Land Space Planning*, in which the measures China currently takes for delineating the three control lines, i.e., ecological conservation redline, permanent basic farmland and urban development boundary, are of great significance and have become the core elements and mandatory contents of the national land space planning. This is a system design for optimizing the systematicness, policy and operability of the development and protection of national land space.

The delineation of ecological conservation redline aims to leave enough space for keeping the natural earth ecosystem healthy, safe and sustainable, which aims to avoid the disturbance from human activities. For example, forest is delineated as a redline because of its strong carbon sequestration and water conservation functions, and so is soil because of salinization in fragile farmland ecosystem. Some problems appeared in the delineation of ecological conservation redline. Despite the mature ecological principles and methods and the professional technical teams at the preliminary stage, the large-scale practice from the release of technical regulations to the demonstration of the delineating plan for the ecological conservation redlines in all provinces did not produce satisfactory results. The reason is that the ecological theoretical method focused on or limited to the evaluation of fragility and importance of ecosystem and ignores the disturbance from human activities.

The policies of ecological conservation redline focus on the management of human activities in the future, involving the occurrence, intensity and manner of human activities that disturb the ecosystem. Such delineation aims to highlight the grading of fragility and importance, while it practically leads to the dislocation of concept and methods from the purpose. The diverse human activities influence the nature in different intensities and manners, and the carrying capacity and suitability to human activities vary among natural ecosystems. For example, salinity land can be used for industrial construction; the forests without water conservation and biological protection functions can carry human activities of reasonable utilization mode and intensity; the fragile alpine grasslands can keep healthy even in the case of grazing in line with the balance requirement between forage and animals.

The ecological theories and methods suitable for the ecosystem composed of human and nature, as well as the determination of the niche for human sustainable development in the balanced natural ecosystem, needs to be addressed to avoid the misleading of the science and technology to the demands. The emphasis of biodiversity conservation has similar problems. When humans are included in an ecosystem, do viruses and harmful bacteria tend to be diverse? Is human exposure increased accordingly? Is the health risk increased? Will the conflict between human and nature be aggravated and lead to increased negative marginal effect of the interaction between human and nature if the biodiversity in a space with intensive human activities is simply highlighted? Ecological safety risks will be produced if we
promote the ecologicalization of cities without solving these problems. In the human development history when people transform natural space into urban space, they actually, to the greatest extent or excessively, avoid the possible negative impact of natural space. Ecological cities should require the controlled biodiversity and optimized ecosystem diversity to maximize the positive effect. However, the relevant theories and methods cannot meet the demands of space governance.

The delineation of ecological conservation redline enlightens us that the largest weakness of science and technology in space governance and construction of ecological civilization is the exclusion of human from the natural science system [10]. In China’s current discipline classification system, the clear definition of natural science and social science and their development strategies cannot solve the increasingly complex problems of ecological civilization and sustainable development today and in the future.

1.3 Absence, dislocation, and overstepping of science and technology in the building of a science and technology power

Due to the absence of science and technology in the strategies of a prosperous and powerful country, China has failed to transform to the science and technology-driven development pattern after four decades of rapid economic growth since the reform and opening up, while the emerging industrialized countries begin their transformation after two decades of rapid growth. This has become a key factor for the low quality of economic development and low industrial competitiveness of China. Since the 18th National Congress of the CPC, the strong dependence of decision making on science has been formed in the construction of ecological civilization, and the major reforms in ecological civilization, including the natural resource balance sheet, the mechanism for monitoring and early warning of the resource and environment carrying capacity, green national economic accounting system and eco-compensation, regionalization of development priority zones and national land space planning system, inspection on ecological and environmental protection and so on are all supported by the scientific research. At the levels of macro decision-making and strategic deployment, the strategy of building a science and technology power has been implemented firstly and systematically in the construction of ecological civilization and the improvement of space governance capacity.

In addition to the absence problems such as the gap between the science and technology support capacity and the national major demands, as well as the dislocation problems such as the misleading of the weakness of science and technology to the implementation of major national strategies, the orientation of science and technology sometimes deviates from the construction of a science and technology power. The phenomenon of insufficient research in the preliminary stage, emphasis on the administrative decision-making, and ignorance of the supervision and management of implementation existed in previous decision-making management in China. The management and decision revision guarantee the scientific decision-making and action. The government must establish a mechanism of supervision, evaluation and adjustment on the basis of the actual development conditions of different regions to timely optimize the regional policies in the ecological civilization construction. It has become an important system to evaluate the states of sustainable development in different regions and analyze the causes of overloading by investigation of the resource and environment carrying capacity, and thus adjust the regional policies. In this process, scientists establish an indicator system and evaluation model, improve the monitoring network of data acquisition, and carry out pilot projects and trial evaluations nationwide, achieving good progress [11–13]. However, this process appears two trends. The first is the continuation of absence. That is, scientists think that the government does not really adopt the results of scientific evaluation for the decision-making management. As the government intensifies the application of the evaluation results, the other trend appears. That is, scientists consider that the decision-making management of the government should be carried out entirely based on the results of the scientific evaluation, and otherwise it is unscientific. This is an overstepping phenomenon of science and technology support in the decision-making management. Scientists evaluate resource and environment carrying capacity in the limited professional fields and with limited considerations, setting the goals and constraints within a limited scope. Undoubtedly, comprehensive evaluation will greatly contribute to the decision-making. However, the decision-making process is more comprehensive than results in terms of fields involved, considerations and selection of goals. Therefore, we can make full use of the science and technology achievements in decision-making management while not simply copy them. For the construction of a science and technology power, the science and technology benefits should be maximized to approach the demands of decision-making management.

2 Difficulties in the response and support of science and technology for the modernization of space governance

The construction of ecological civilization is an important means for China to build a modern socialist country in all respects. The modernization of space governance is an important system guarantee for both of them. Therefore, the modernization of space governance is the key for building a science and technology power. The two decisive processes in the construction of ecological civilization and the modernization
of space governance are legalization and scientization. Since the 18th National Congress of the CPC, the strategy of building a science and technology power has been fully implemented in the construction of ecological civilization and the modernization of space governance, which reflects the strong dependence of relevant decision-making management on science and technology. Decision-making demand for the construction of ecological civilization and the modernization of space governance is strong, urgent and growing. Therefore, a framework for analyzing demand for and difficulties in science and technology should be established for the modernization of space governance using the goal-oriented and problem-oriented approaches. This is an effective way to formulate the adaptive strategy for the modernization of China’s space governance.

2.1 Framework of science and technology demands and response for modernization of space governance

In a long period of time, the modernization of China’s space governance will remain to be led by the government. Comprehensively deepening the reform in the system and mechanism of decision-making management has become a key measure in the government-led process. Accordingly, the framework of science and technology demand and response in the modernization of space governance mainly consists of four parts (Fig. 1). The demand-driven property includes two parts: increases in the public risk of decision-making management and in the complexity and uncertainty of decision-making objects. The response property covers all the four parts: reduction of decision-making risks, response to the complexity and uncertainty of decision-making objects, improvement of adaptive strategy of governance, and exertion of scientific value.

![Fig. 1 Framework of science and technology demand and response](image)

The increase of social public risk in decision-making management is one of the core driving forces of this framework. At present, the governance capacity is related to governance capacity, and erroneous decision-making management will pose social public risks, leading to losses at different space scales (globally, nationally or locally). It is even associated with the fates of human beings and a nation. This is true for the post-disaster reconstruction of Wenchuan earthquake, the global fight against COVID-19 pandemic, and the guarantee of national security and food security. Therefore, the modernization of governance capacity based on science and technology support has become a conscious demand and an inevitable choice for decision-making management.[14]

The increasing complexity of the objects of decision-making management and the increasing uncertainty of the evolution of objective things is another core driving force of this framework. The openness of space, the formation of flowing space, the interaction between material space and nonmaterial space, and even the cognitive and emotional differences in space quality may become the main reasons for the uncertainty and complexity of the national land space. When space governance must be modernized, strong science and technology support must be provided.

Science and technology response to space governance demand is derived from the adaptation to the above core driving forces as well as the scientization of governance. Governance, a subject of public management science, is closely associated with scientific value orientation, service for the society, and addressing of space sustainability issue in human development. Therefore, orientation towards space governance demand drives the development of science and technology. The modernization of science and technology is the basis and an effective approach for building a science and technology power.

2.2 Science and technology innovation framework for space governance

The science and technology innovation framework for space governance consists of three hierarchies (Fig. 2). (1) Theoretical innovation. A science and technology system with the integration of natural science, social science and engineering technology, i.e., a big science system, should be established and innovated for the modernization of space governance. (2) Basic capacity. Importance needs to be attached to the basic data acquisition, sharing and analysis capacities, as well as the simulation, prediction and model optimization methods. (3) Knowledge application. This hierarchy includes the construction of the whole chain of the creation and inheritance, learning and spreading, and application of science and technology knowledge for the modernization of space governance, and the key is to realize the efficient combination of research with decision-making[15,16].
2.3 Key scientific problems of space governance in the construction of a science and technology power

Since the 18th National Congress of the CPC, the increasing demand of the construction of ecological civilization and the modernization of space governance for science and technology application has vigorously stimulated the development of relevant research fields, such as the mechanism of formation and evolution of regional function, evaluation method of natural carrying capacity and suitability of regional function, new and sustainable urbanization process [19], and rural revitalization and sustainable livelihood in underdeveloped areas [20]. In addition to the above geographic studies, the ecological studies (e.g., the green capital accounting system and mechanism of ecological compensation) [19], the biological studies (e.g., ecological security barrier and natural protected areas) [20], as well as the studies of the coupling effects of cultural diversity, and the biodiversity [17], have also been promoted. These studies form the system supporting the construction of ecological civilization with Chinese characteristics, which is of international significance for human geography and national land space planning. The research on human geography in China has started to show a spillover effect, and the national land space planning has been transformed from completely learning from foreign countries to mutual exchange. That is, foreign experts begin to learn from China [21].

Despite the development of science and technology supporting the space governance system, fundamental breakthroughs have not been made. In particular, the big science, including the sustainability science, has not emerged; the platform and mechanism of data acquisition and sharing have not been established; the barriers in scientific research and decision-making have not been fundamentally broken. In general, there are still the following eight key scientific problems that remain unresolved for space governance in the construction of a science and technology power [7,22].

1. Understanding of the changing space and the comprehensive benefits of all space elements. The focus on current surface spatial process is shifting from resources to all the elements, and from the coupling between nature and human activities to the multiple coupling of nature, economy and culture. Realization of the interaction between basic constraints and goal system with optimal comprehensive benefits in the whole space system is a scientific basis for understanding the basic concept of the changing surface space.

2. Description of the basic driving force and stable state of spatial process. The process of spatial change is absolute and its result is a stable state toward spatial balance. Considering the comprehensive spatial benefits, the spatial evolution model involving the economic benefit balance will be overturned. Further, the cognition that the regional disparity of economic development is the basic driving force of the spatial change will also be denied. How will the stable state of spatial change include economic, social and ecological benefits? The basic driving force is the difference or disparity, while the realization of dimension conversion of disparity of different categories means the interdisciplinary integration.

3. Matching of the government management in the socialist system with Chinese characteristics with the market effect of a socialist market economy. For the best governance effect, the basic mechanism of matching cannot be explained only by the classical theory of marketing economics or by the theory of spatial organization under the premise of hypothesis of rational man. In addition, the matching of rigidity and elasticity, together with the short-term and long-term matching of governance approach, also become the difficult problems in the optimization of spatial regulation.

4. Theoretical innovation. The tremendous change of the world in the future leads to the emergence of new influencing factors of spatial process and space governance, and the new space types, new space open system and space interaction mode necessitate theoretical innovation [23]. For example, the theory of urbanization premised on the basis of urban area superior to rural area loses the premise of its existence; three industries are highly integrated at the micro level, and thus the traditional spatial division and functional zoning lose the objects they carry; it is hard to select the diversified judgements of the effects of cultural diversity, and the biodiversity also faces the same challenges.

5. Prediction of the future and adaptation of space governance in a long period of time. The external landscape and physical space we see are often stable, while the social structure, cultural connotation and even spatial efficiency have undergone tremendous changes. The prediction of the future and adaptation of space governance in a long period of time are the problems of time effect and process optimization of space governance. What are the conditions for the turning point of time from short-term optimum to long-term optimum? What is the reasonable regulation mechanism that we should adopt to make a satisfactory process?

6. Optimization of spatial process. Spatial process is
closely related to time process, including the cascade system and conduction effect in the spatial scale transformation, as well as the interaction between the part and the whole, and between different regions. However, since the conduction and cascade objects in the space have been extended from ecological function and economic benefits to the whole system, can function, efficiency and quality be synchronous in the spatial scale transformation and spatial interaction? It is definitely out of sync, and thus what such spatial process mean for space governance has to be solved urgently. In fact, in the basic contradictions China is faced with for a long time, central and local contradiction and domestic and overseas contradiction, as two basic ones, are produced by the inconclusive optimization of spatial process.

(7) Production of differential media effect of the soft environment composed of system, mechanism and social culture. The research on the differential media effect is the scientific basis for the creation of the value orientation with local characteristics. The effect of space boundary (interface) is changing the basic laws of the motions of matter, energy and information, and the changing trajectory of objective things is deformed in different media. This has shown a good result in natural science. In contrast, there are few research results in the effect of cultural boundary on the change of objective things. When people cross the cultural boundary through national boundaries, the behavioral patterns may immediately change. When funds are distributed in different administrative regions, the utilization efficiency of funds and the cost-benefit ratio may also change significantly.

(8) Scientific problems related to systematization. Space governance is a system involving systematization-related problems such as public management and engineering and optimization of complex system, most of which are not included in the category of science and technology. On the scale of the whole earth, planning, policy, and law and so on are undoubtedly the governance tools in the self-organizing system of human society. From global to national and local governance, the changes of governance tools lead to the changes of ideas, emotions and values. Therefore, how to reasonably combine different governance tools to achieve efficient governance has also become a proposition of big science. Similarly, the effective conjunction and positive interaction between scientific research and decision-making, exertion of the roles of machines and human in space governance, and intelligent management that combines norms and intelligence are also gradually included in the category of these scientific problems.

3 Adaptive strategy of geographical science for national land space planning

The key scientific problems for the modernization of space governance are not among any single discipline. Even problems are integrated in multiple disciplines and fields, their boundary is obscure. In the future, the adaptive strategy of space governance in the construction of a science and technology power can be discussed by the combinations of goals and problems, the weaknesses of science and technology with major demands, and the law of science and technology with system characteristics. In this way, science and technology can play a great role of support in the modernization of China’s governance system and governance capacity.

In recent years, the national land space planning grows fast, which can be confirmed by the positioning of China’s governance system, the adjustment strength and work state of central authorities. National land space planning, especially that on the medium scale and large scale, is an important part in the application of geographic science. When the research object, theoretical basis and analysis method follow the paradigms of the integration of natural science and social science, developing a unified geographic theory system and improving the system capacity of serving the society will become the basic strategy for the development of geography. This strategy takes the actual evolution of the national land space as the observation objects and the experimental field and finds our major scientific problems from the reality and the real national land space, aiming to solve major scientific problems. This is also an adaptive strategy of geographical science for national land space planning.

3.1 Reconstruction of a unified geographic theory system for national land space planning

The reconstruction of a unified geographic theory system should be discussed considering the whole process and key demands of national land space planning. Specifically, the planning goal, analytical methods, layout plans, control system optimization, safeguard measures and dynamic management should be considered. The characteristics of geography, as well as the advantages and potential of the current branches of geography, can be taken as the targets.

(1) Core theoretical basis for determining the goal of national land space planning. It is necessary to determine the equilibrium theory of the evolution of national land space pattern oriented towards the goal of sustainable and high-quality development. The evolution of spatial pattern has its own law, and the interaction between elements is objective. However, their regulation mechanism and realization path are different due to the different goals. For the equilibrium of spheres in the natural system, that of population and economy with resources and environment, and that of human production and living space with social and cultural space, the status and realization mechanism is the basic theory of unified geography that explains all the important geographical processes and patterns.

(2) Theoretical basis for developing the technological methods of national land space planning. Revealing the coupling between natural environment system and human social system based on geographical research is undoubtedly...
an important theoretical tool for the sustainability on different scales (globally, nationally and locally). The disciplinary development should be promoted in the order of the discussion of the sustainability of natural elements such as resource, environment, ecology and disaster, the integration of these elements into a carrying system of a natural complex, the expansion of them to the infrastructure system formed after the modification of the earth by humans, and the conversion of resource and environment carrying capacity to the synthetic natural carrying capacity and further space carrying capacity. On the contrary, there are also abundant propositions in the action of human social system on natural environment system, and the coupling problem with the highest theoretical value in geography can be solved only by the interaction between nature and human.

(3) Theoretical guideline for allocating the national land space or developing the national land space layout. The focus of geography lies in the regional difference and zonality or the distribution law of space structure. The basic unit of the difference is regional function, and zonality and space structure reflects the spatial combination law of the regional function. Planning is essentially the development of the goal-oriented spatial organization, the approach of which is to establish the relationship between regional function and policy unit and reasonably allocate space. Therefore, the formation of the basic relationship and type system of regional function–spatial structure becomes an important theory for the planning of national land space, including the cognition of regional function suitability, the mechanism of spatial structure in response to the evolution of regional function, the ordering process and driving force of spatial structure, the control valve and benefit of spatial structure optimization.

(4) Theoretical framework of establishing the national land space planning system and realizing the systematization of space governance. The spatial interaction and the conduction mechanism of different spatial scales can also be generally understood as the interaction between spaces of different levels (scale), the local and the whole space, and spaces of the same scale (level). What factors determine the direction, strength, efficiency and effect of different conduction objects or action carriers in the interaction? Does their cumulative effect show a linear change in the integration of different conduction objects and action carriers? Is there a “turning point” in this change, and what are the conditions for the “turning point”? All these problems need to be discussed urgently.

(5) Theoretical explanation of main body and major measures of national land space planning. The way adopted by modern space governance to realize the will of the government has not limited to hard-and-fast rule and strong constraint, which has been proved to show simple optimization rather than systematic optimization, and even has the risk that the negative effect outweighs the positive benefits. Then, the national land space planning scheme, which involves the exertion of the role of the government, market and other forces of the whole society, needs the recognition of applicable categories, action mode, and positive and negative effects of different forces. The combination of different acting forces varies with the changes in space and time. Therefore, the way to optimize the operation plays a decisive role in making a plan effective.

(6) Theoretical reference for the implementation, monitoring and evaluation of national land space planning. This is a decoupling process—the reverse research on the results of forming and implementing the national land space plan. The analysis of the national land space pattern at a certain stage or final stage and tracing back to the process producing the result and the component of various acting forces can reveal the cause of the formation of the pattern, which facilitates further optimization of the national land space plan [28]. The difficulty in solving the problem is that the process and mechanism of coupling and decoupling are not completely coupled. When we set a scheme to realize a planning goal, we actually just give an approach or a process of the coupling. However, when we evaluate the planning result at a time point, the approach and process that produce the result may be not the only one, or not the approach and process given by the planning. This creates a problem for decoupling. It is worth exploring the cause of this uncoupling.

![Theoretical innovation system of unified geography for national land space planning](image)

**Fig. 3** Theoretical innovation system of unified geography for national land space planning

### 3.2 Consolidation of the unified geographic data foundation for national land space planning

There are two major issues of developing a unified geographic theory system and data foundation for national land space planning. The latter includes the work in the field of science and technology (such as establishing the ground-air-space data acquisition network) and the work in other fields (such as improving the data sharing mechanism). Because they play a decisive role in consolidating the data base and realizing the strategy of a science and technology power in space governance. In particular, the development of big data creates the data conditions and method models for improving the research quality of social and immaterial space, which should be included in the construction of data foundation [29].
From the perspective of technical method, the construction of data foundation platform should involve analysis, evaluation, management optimization and information publish. With the aid of the latest information technologies such as big data and cloud computing, the data foundation platform mainly provides data acquisition, searching, comprehensive analysis and other services for the developer and evaluator of national land space planning. Meanwhile, it provides the presentation window for the management department and the whole society [30]. The dynamic acquisition of various natural and cultural data, the integration of multi-source heterogeneous data, comprehensive analysis, space expression, and the on-demand service of information resources will help to improve the scientficity of national land space planning.

From the perspective of technical standards, the data foundation platform should be uniformly arranged and designed according to the demands and the following principles. (1) Integrity and standardization. We should design the system plan as a whole according to the unified framework of business integration by taking full consideration of all aspects and the system demands, establish the application norms, and follow the unified business concept, indicator and standard. (2) Advancement and maturity. The advancement and maturity should be considered in the design concept, technology system and product selection to meet the maintainability and scalability of the system in a long life cycle. (3) Safety and reliability. To have a perfect and precise security system, we should take all respects and multiple levels into account. That is, we should ensure the security and reliability of the whole system at the application and system levels. (4) Manageability and maintainability. The management, operation and maintenance should be as easy as possible.

We can construct a data foundation platform composed of the base layer, data layer, service layer, and application layer. (1) The base layer mainly includes the natural and social data monitoring and acquisition system. The traditional data acquisition network and the new big data method at the data acquisition layer should be combined, and the natural data and cultural data should be fused. (2) The data layer, with the core of database establishment, mainly includes the basic database and thematic database of various elements, real-time monitoring database, basic geographic database, and thematic spatial database. The fusion and management of data are conducted in this layer. (3) The service layer including algorithm base and model base is a core layer of data service planning, which supports the implementation of various service functions at the application layer. Model base is a collection of various model components supporting the platform functions, and algorithms base involves the basic analysis methods and underlying algorithms contained in various models. (4) The application layer is an application system of the platform for the users at different levels of spatial planning, which facilitates the management and application of various services.

References

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