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Systemic Governance of Mountains, Rivers, Forests, Farmlands, Lakes and Grasslands: Theoretical Framework and Approaches

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The life community of mountains, rivers, forests, farmlands, lakes and grasslands (MRFFLG) and its systemic governance are key components to build ecological civilization in China. It comprises diverse connotations in value, scientific and economic dimensions. Epistemologically, it comes from the Chinese traditional philosophy of harmonious coexistence of heaven, earth and man, and conforms to the Western ecological ethics, complex system science and environmental value theory. Methodologically, as a complex socio-ecological system in which man and nature interact and coexist, the life community of the MRFFLG should be governed coordinately from both narrow and broad views. At the policy level, from the perspectives of narrow synergy among ecological subsystems and broad synergy among the complex socio-ecological system, this paper evaluates the performance indicators of 16 pilot projects of the MRFFLG, and points out that the design of most pilot projects well reflects the narrow synergy of multiple ecological elements, but is short of attention to the broad synergy of green development and ecological civilization. There are two practical ways to promote the systemic governance of the MRFFLG. First, it needs to focus on the coordinated governance of watershed and ecological environment restoration against the background of global climate and environmental change. The goal is to restore and improve the service functions of ecological subsystems and enhance their climate adaptability. Second, in the context of new urbanization and green development transition, it requires a collaborative planning focusing on natural capital and green infrastructure investment, which is aimed at cultivating ecological dividends and realizing ecological economy.

Keywords: Ecological civilization; the life community of mountains, rivers, forests, farmlands, lakes and grasslands; systemic governance; complex socio-ecological system; synergy.

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1. Introduction

The overall planning on the systemic governance of mountains, rivers, forests, farmlands, lakes and grasslands (MRFFLG) is a reflection on the environmental and development issues in the process of China's reform and opening-up. In the rapid development of over 40 years, the GDP-oriented performance assessment resulted in the phenomena of draining the pond to get all the fish and exhausting the forest to hunt all creatures in many regions of China. The MRFFLG suffered damages to various degrees. To restore the vitality of this community of shared life, it is necessary to strengthen the protection and restoration of all kinds of natural ecological elements. In November 2013, the General Secretary Xi Jinping first pointed out that mountains, rivers, forests, farmlands and lakes are a community of shared life (Xi, 2013). In September 2016, three ministries including the Ministry of Finance (MOF) issued the *Notice on Promoting the Ecological Protection and Restoration of Mountains, Rivers, Forests, Farmlands and Lakes*, which pointed out that accelerating the ecological protection and restoration of mountains, rivers, forests, farmlands and lakes, realizing structural optimization, system stability and functional improvement were important to construction of ecological civilization and a beautiful China, and to the ecological security and sustainable development of the Chinese nation (MOF *et al.*, 2016). In October 2017, Xi Jinping's report at the 19th CPC National Congress pointed out that "We must realize that lucid waters and lush mountains are invaluable assets and act on this understanding ... cherish the environment as we cherish our own lives. We will adopt a holistic approach to conserving our mountains, rivers, forests, farmlands, lakes, and grasslands ... continue the Beautiful China initiative" (Xi, 2017). In April 2018, according to the *Institutional Reform Plan* of the State Council, the Ministry of Natural Resources (MNR) was formally established to uniformly exercise the responsibilities of the owners of natural resources assets owned by the whole people. The newly established MNR integrated the original Ministry of Land and Resources, State Oceanic Administration and National Administration of Surveying, Mapping and Geoinformation, and took responsibilities of managing urban and rural planning and natural resources like rivers, forests and grasslands, which helped change the fragmented management drawbacks and implement overall protection of natural resources property rights from institutional level. In August 2018, the Ministry of Ecology and Environment (MEE) distributed the *Opinions on Further Deepening the Reform of Streamlining Administration, Delegating Power, Strengthening Regulation and Improving Services in the Field of Ecology and Environment, and Promoting High-Quality Economic Development*, stating that in the construction of eco-civilization demonstration areas and pilot projects of the MRFFLG ecological protection and restoration, the areas with innovative ecological environment governance models and mechanisms will be supported (MEE, 2018). This revealed the strategic and

fundamental significance of systematic governance of the MRFFLG for China's ecological civilization construction.

General Secretary Xi Jinping pointed out that nature is an interdependent and mutually influencing system. For example, mountains, rivers, forests, farmlands and lakes are a community of shared life. The lifeline of man lies in farmlands; that of farmlands lies in rivers; that of rivers lies in mountains; that of mountains lies in soils; and that of soils lies in forests. If those who plant trees only care about trees, those who govern water only think of water, and those who protect farmlands are only concerned with farmlands, it is easy to attend to one thing and lose sight of another, and eventually cause systemic damage to the ecology (Publicity Department of the CPC Central Committee, 2016). This statement inherits the wisdom of the traditional Chinese philosophy of the unity of heaven and mankind and the harmony of heaven, earth and man, and embodies the eco-civilization values of sustainable development of economy, society and natural environment (Wu and Zhang, 2018; Zhao, 2018). It stresses that the ecosystem is holistic, systematic and comprehensive, and is an understanding of the relationship between mankind and earth in a larger context. The farmlands produce the grains that sustain human life; water nourishes the farmlands and makes them sustainable; mountains gather water and nourish the soil; and mountains, water and land (including climate, topography, etc.) constitute the physical environment of the ecosystem (Huang *et al.*, 2014). Among the existing researches related to the MRFFLG, the keywords like "the shared life community of MRFFLG", "Systemic Governance", "Ecological Protection", "Protection and Restoration", "Land Remediation", "Ecological Protection Red Line", "Human-land Synergy Pattern", "Ecological Service Function", etc. are hot topics (Zhong *et al.*, 2020). The local pilot practice mainly includes watershed management, ecosystem (lands, grasslands, forests, mines, etc.) protection and restoration, soil and water conservation, landscape planning, pollution control, sponge city construction and other related fields.

At the theoretical and methodological levels, some articles analyzed the content and effectiveness of the pilot projects and explored the connotation, theoretical basis and technical approaches of the life community of the MRFFLG. There are two main perspectives for understanding the systemic governance of the MRFFLG. The first is to emphasize the coordinated governance of ecosystem elements. Most studies analyzed the systemic governance of the MRFFLG from the perspective of integrated management of ecosystem or natural resources. For example, Huang and Yang (2016) pointed out that the sustainable use of natural resources is the basis of the community of shared life, and suggested the construction of a new natural resources management system that takes land elements as the carrier and property rights management as the core, and is led by the market with multi-departmental collaboration. Wu *et al.* (2018) suggested that a whole-process governance of the MRFFLG should be realized to solve new and old water problems such as water shortage, water environment pollution, water ecological damage and water disasters. From the perspective of system science and landscape ecology, Liu and Yu (2016) argued that the goal of ecological protection and restoration of the MRFFLG was to improve the ecological landscape service function. Wang *et al.* (2018) pointed out that ecosystems request multi-objective and multi-factor integrated management, and the

essence of the shared life community of the MRFFLG is to establish a concept of natural values and change the protection and restoration of single elements to that of enhancing the service functions of ecosystems. The second is to emphasize multi-system and multi-scale coordinated governance. Some scholars have recognized that the systemic governance of the MRFFLG belongs to the category of socio-ecological systems (SESs). For example, based on ecosystem ecology, composite ecosystem and sustainable development theory, Wu *et al.* (2019) pointed out that the life community of the MRFFLG had a composite architecture of social, economic and natural ecosystems. Wang and Zhong (2019) pointed out that the restoration projects of the MRFFLG and their regulation had effects at different scales and should be managed from the economic, social and eco-environment subsystems, so that the ecosystem can provide high-quality ecological products. Li *et al.* (2018) proposed the concept of the "MRFFLG-Man Community of Shared Life", and believed that the functions of the community should be enhanced by strengthening holistic protection and comprehensive governance, coordination between the mankind and the ecological environment as well as cooperation between multiple departments and regions. Zeng *et al.* (2020) argued that cities, as symbols of human civilization and populated centers, should strengthen the evaluation of the health of the MRFFLG–city life community. Luo *et al.* (2019) pointed out that the ecological protection and restoration projects of the MRFFLG had achieved multiple ecological, economic and social benefits. From the national perspective, they helped to maintain national ecological security and enhance regional ecological functions. From the local perspective, they could take into account the ecological protection and restoration of both urban and rural areas, and promote green development.

2. The Theoretical Basis of Systemic Governance of the MRFFLG

Seen from the theoretical origin, the systemic governance of the MRFFLG life community reflects the cognitive view of system science. It covers three levels: value connotation, scientific connotation and economic connotation.

2.1. *The value connotation of systemic governance of the MRFFLG*

The systemic governance of the MRFFLG life community has diverse value connotation, which is mainly reflected in the contribution of maintaining the ecosystem service functions, social and cultural values and existence value. In terms of ecological attributes, the UN *Millennium Ecosystem Assessment Report* categorizes the benefits that humans derive from ecosystems into the following ecosystem service functions: (1) provisioning services, referring to the food, bio-fuel, fiber, building materials, water, medicine, gene resources, etc. that people can obtain from ecosystems; (2) regulating services, referring to the functions of air purification, disaster mitigation, climate regulation and water purification; (3) supporting services, referring to the functions that form primary productivity, and produce soil and oxygen; (4) cultural services, referring to the functions of providing spiritual enjoyment, recreation, education and aesthetics; and (5) biodiversity, referring to the combination of specific ecosystems and their biological structures and functions.

From the perspective of social and cultural attributes, the idea of shared life community of the MRFFLG embodies the moral responsibility of human beings to ecosystems and represents a reflection on the increasing departure of modern civilization from the harmonious coexistence of man and nature. Traditional Chinese culture advocates respect for the nature of mankind and all beings, and takes "harmony" and "moderation" as the guidelines for the harmonious development of heaven–earth–mankind. By observation of celestial and physical phenomena over time, the ancient Chinese discovered the systemic correlation between heaven–earth–mankind and the cyclical pattern of climate change. They applied this law of nature in the fields of health preservation, family harmony, state governance, agriculture, disaster relief and other fields. Western environmental ethics extended the concept of human morality and rights to the natural world. For example, the American Philosopher Leopold in his signature work, *A Sand County Almanac*, first proposed "The Land Ethic", which considers natural resources management as a moral issue and recognizes the rights of living beings and nature. "The Land Ethic" implies respect for his fellow-members, and also respect for the community as such, and therefore, human beings have a legitimate ethical obligation to protect and support the biological community (Yang, 2003). "The Land Ethic" embodies the ecological holism and ecological community concept, emphasizing the ecological ethics of the harmonious development of human–society–nature, which helps promote human society towards a green ecological civilization (Zhang and Xiao, 2012). The outlook of human beings determines the way they treat their surroundings. Environmental ethics expand the value of existence from humans to organism and ecosphere, highlighting the concept that everything has intrinsic value and becoming the basis for reshaping social values and achieving sustainable development (Fang, 2019).

2.2. *The scientific connotation of systemic governance of the MRFFLG*

Ecosystem science is the scientific basis for the systemic governance of the MRFFLG. Ecosystems could range from the local to global, and their governance can be understood from narrow and broad dimensions. Wu *et al.* (2019) pointed out that the life community of the MRFFLG is supported by the theory of ecosystems and aims to achieve ecological protection, ecological functions enhancement, ecological service optimization and other functions, based on the principles and technologies of watershed ecology, restoration ecology, landscape ecology and complex ecosystem ecology. From a global and broad perspective, the Earth is the largest ecosystem for human existence, and the development of human civilization is a history of human–nature interaction and symbiosis, and human modification of the natural environment has led to global environmental problems. In the 1960s, British and American atmospheric scientists and ecologists jointly proposed the Gaia Hypothesis, which believed that the interaction between organisms and the environment jointly shaped the life system on Earth. As a new view of the Earth system, the scientific meaning of Gaia Hypothesis is that every species in the Earth's biosphere is interrelated and interdependent, and the ecological and environmental issues concern the destiny of the entire Earth and human beings. At the 35th International Geological

Congress in 2016, scientists reached a consensus and stated that the Earth has entered a new geological epoch — the Anthropocene, and human activities become a major driver of changes in the dynamics of the Earth system. A distinctive feature of Earth's entry into the Anthropocene is the issue of global climate change triggered by human activities in the last 100 years. The impacts of climate change on humans and ecosystems are profound and long-lasting, for which global governance needs to be strengthened (Young, 2019). The idea of building a Community of Shared Future for Humankind proposed by General Secretary Xi Jinping reflects the scientific nature of the traditional Chinese cultural concept of "harmony and coexistence of heaven–earth–mankind". On the one hand, it needs to be recognized that the systemic governance of the MRFFLG carried out in Chinese regions is a fundamental work of regional or even global ecological and environmental governance, and it is China's positive contribution to the global community of shared future. On the other hand, it is also necessary to pay attention to the long-term impact of global climate and environmental changes on the restoration and protection of China's ecosystems, so as to take the initiative to strengthen forward-looking planning and adaptive management of human activities, and to deepen understanding and achieve sustainable development of the complex SESs.

2.3. *The economic connotation of systemic governance of the MRFFLG*

The shared life community of the MRFFLG is the core element of ecological civilization, which embodies the value of using natural capital as the new engine of green development. Natural capital is an important element of social welfare, including two major components: natural resources products and ecosystem services, and it refers to the stock of natural resources and environmental capital such as ecosystems, species and genes that can provide ecological services and bring ecological benefits in the present or future (Zhang and Liang, 2014). The World Bank divides a country's wealth into manufactured capital, human capital, natural capital and social capital. And in its report *The Changing Wealth of Nations 2018: Building a Sustainable Future*, the World Bank states that natural capital such as forests, farmlands, nature reserves and minerals accounts for 1/10 of global wealth. Although the vast majority of natural capital is in developing countries, developed countries have much higher levels of natural capital per capita than low-income countries, suggesting that economic growth does not necessarily come at the cost of depleting natural capital (Lange *et al.*, 2018). In 2011, the UN Environment Programme, in its report *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*, stated that a green economy was an economy based on the appreciation of natural capital. If 2% of the global GDP is invested every year to support the green economy, the growth of global economic output from 2020 to 2050 will consume less natural capital and even improve ecological environment (Zhu, 2012). The World Bank pointed in its report, *Economics of Adaptation to Climate Change — Ecosystem Services*, that restoring 350 million ha of degraded land in the next decade could add USD 9 trillion to the value of ecosystem services worldwide (Lange *et al.*, 2010). The European Environment Agency (EEA) pointed out that green infrastructure as one of the Nature-based Solutions (NBS)

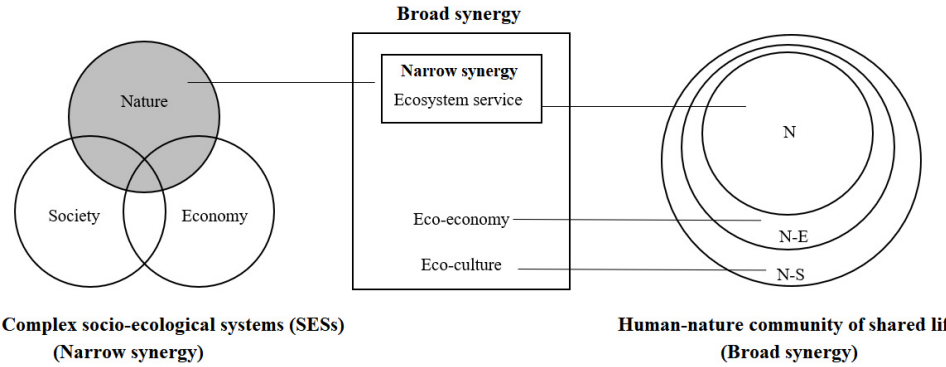
provides various ecological services such as biodiversity conservation, climate change adaptation and mitigation, water resources management, food supply, land conservation and development, recreation and cultural benefits. EEA encourages EU Member States to strengthen green investments and promote green economy through green infrastructure spatial planning (Fan, 2019). In recent years, many countries have taken the construction of green infrastructure (e.g. the maintenance, management and restoration of natural ecosystems and the construction of man-made wetlands, urban forests and green corridors) as a major means of enhancing natural capital stocks and social well-being.

3. The Methodology of Systemic Governance of the MRFFLG

In a broad sense, the shared life community of the MRFFLG is not only a natural ecosystem but also an integral part of the human habitat. Human society is one of the elements of the complex socio-ecological systems, and coordinated governance is a requirement for this complex system.

3.1. *Complex SESs*

The complex SESs are one of the core concepts of Complexity Sciences, which emerged in the 1980s. Complex systems are characterized by human–environment interactions, such as tightly interconnected system components (coupling mechanisms), nonlinear patterns of change (with triggers and thresholds of change), dynamics and tendencies of development process and system path dependence disrupted by sudden events (Young, 2019). The American Scientist John Holland proposed the Theory of Complex Adaptive Systems (CAS), which believes that a complex system is an organic whole composed of multiple subsystems and multi-level elements. It can adjust to changes in the external environment, fully learn from and adapt to the environment and form a system structure with dynamic stability. Openness, nonequilibrium, and uncertainty are its norm (Huang, 2006). For the governance of complex systems, some scholars have proposed synergistic and collaborative governance theories. Ostrom (2009) introduced the concept of complex SESs into social sciences research, arguing that the disciplinary boundaries between ecology and social sciences should be broken down and the understanding of the mechanism of this complex system should be strengthened to enhance the sustainable management of public resources. Wang and Ouyang (2012) proposed the concept of "social–economic–natural complex ecosystem", which notes that social, economic and natural subsystems are the adaptive actors of the complex system, and the core is the integration of ecological structures and functions, so as to achieve the harmonious and sustainable development of the three subsystems. Qiang and Fan (2017) analyzed SESs from the perspective of green values, pointing out that natural systems provide various materials and energy for economic development, and the sound development of economic systems further provides capital investment for nature protection. Systems thinking must be applied so as to avoid crossing the thresholds of SESs.



Source: Made by the authors.

Fig. 1. Two governance dimensions of the MRFFLG.

3.2. *Coordinated governance in complex SESs*

The complex system of the MRFFLG includes the three attributes of ecology, society and economy (see Fig. 1): (1) Ecological attributes (nature: N), referring to the characteristics of each ecological element of the MRFFLG and their shared biodiversity, ecological service functions, etc.; (2) social attributes (nature–society: N–S), referring to the social and cultural values of the MRFFLG as a biophysical environment in terms of humanities, history and landscape. For instance, Mount Tai, Mount Huang, Mount Emei, Leshan Giant Buddha and Mount Wuyi are listed in the World Natural and Cultural Heritage List; the Honghe Hani Rice Terraces System in Yunnan was recognized as a unique agricultural cultural heritage by the Food and Agriculture Organization of the United Nations; and Mount Wuling in Hunan was endowed with the national natural and cultural heritage, important agricultural cultural heritage, etc.; and (3) economic attributes (nature–economy: N–E), referring that the MRFFLG, as an important material basis of life and source of livelihood, has economic values. It can create employment and provide primary products such as food, agriculture, forestry, animal husbandry, fishery, etc. For the human system, ecological subsystems are an integral part of the SESs through the realization of values, i.e. natural capital. The system of the MRFFLG with different dimensions and multiple attributes is a complex, symbiotic and organic community of shared life. It is necessary to fully respect and utilize the integrality of this complex system, instead of dividing it and governing its subsystems separately. It is suggested to realize holistic protection, systematic restoration and comprehensive management in policy and practice.

Based on the concept of complex SESs, the systemic governance of a shared life community of the MRFFLG has two governance dimensions (see Fig. 1). One is the narrow synergy of all elements of the natural ecological subsystems, including the ecological protection and restoration of mines, farmlands, forests, wetlands, grasslands and other subsystems, as well as the comprehensive governance of watershed environment, etc. The second is the broad synergy between the natural ecological subsystem and the social and economic subsystems after their continuous integration and coordinated development. This new sustainable development system depends on a balanced and orderly operation of

every internal subsystem to realize the coexistence and synergistic evolution of ecology, economy and society. The intersection of the natural ecological subsystem with the social and economic subsystems (N–S and N–E) is further expanded to the entire socio-economic system, including ecological landscape design for human living environment, urban ecological planning, green infrastructure and eco-industrial development. The three subsystems based on the intrinsic value of ecosystems and their evolutionary principles together constitute the human–nature community of shared life.

The concept of complex SESs embodies the essence of human–environment interaction, so that the effectiveness and sustainability of restoration and conservation depend to a certain extent on the perspective and scope of governance. The narrow synergy aiming at restoration and protection of ecosystem service functions can bring about beautiful ecological environment and living environment. The broad synergy aiming at cultivating natural capital, ecological economy and ecological culture is the fundamental path to green development transformation and the construction of Beautiful China and ecological civilization.

4. Policy and Practice of Systemic Governance of the MRFFLG

4.1. *Progress and assessment of the pilot projects of the MRFFLG ecological protection and restoration*

The pilot projects on the ecological protection and restoration of the MRFFLG were launched in 2016 and a total of 25 pilot projects have been implemented as of 2019. The pilot policy specified that the fiscal and policy funds are mainly used to support core areas affecting the national ecological security, key areas relating to the sustainable development of the Chinese nation and where ecosystems are severely damaged and where it is most urgent to carry out treatment and restoration. The pilot funds come from special transfer payments of "land, sea and meteorology expenditures". Each project received 2 billion yuan of central financial subsidies, with local counterpart funds of over 5 billion yuan. The pilot projects focus on the integrated governance of five aspects, namely mine environment governance and restoration, land remediation and pollution repair, biodiversity protection, watershed protection and treatment, and comprehensive system governance and restoration. The pilot projects basically cover various types of ecological security and ecological space in different regions.

According to the Engineering Construction Contents of 16 Pilot Projects in 2017–2018 released on the website of the MOF, this paper classified the performance assessment indicators according to scales and content of collaborative governance elements (see Table 1). *The National Ecological Function Zoning (Revised Version)* released in 2015 classified ecosystem service functions into three types: ecological regulation (water conservation, biodiversity protection, soil conservation, wind break and sand fixation, and flood diversion), product provision (agriculture and forest products) and habitat protection (densely populated and economically developed metropolitan areas and key urban clusters). Referring to the narrow synergy and broad synergy governance, the performance indicators of pilot projects construction are classified in Table 1. Among them, the

Table 1. The management content and indicators of some pilot projects of ecological protection and restoration projects for MRFFLG from 2017 to 2018.

Dimension	Synergy elements	Examples of key indicators
Narrow synergy	Mountains: mine environmental governance and restoration	Ecological restoration of mine area, rate of restoration and remediation of the geological environment of historical mines, number of abandoned mines for restoration and remediation, size of collapsed coal mines for remediation, volume of mining void areas for comprehensive governance, number of abandoned mines for governance, size of new mines for restoration, number of open pits/abandoned workplaces without responsible entity for governance, green coverage rate of mining areas, mine dust prevention and control compliance rate, rate of production mines included in the National Green Mines List, etc.
	Water/lakes: rivers, lakes and watershed environment protection and governance	Excellent water quality ratio between the main stream and its tributaries, compliance ratio of drinking water sources within the basin, excellent water quality ratio at the cross-section under national or provincial monitoring, excellent water quality ratio in the basins, ratio of surface water quality at or better than Grade III, ratio of surface water quality inferior to Grade V, ratio of seawater quality inferior to Grade IV, ratio of water bodies with water quality inferior to Grade V, reduction value of major pollutants, etc.
	Forests: forest protection and quality improvement	Size of forest protection and tending, size of forests stand structure transformation, ratio of ecological transformation area in the original area, forest coverage in the project areas, area of forest for precise quality improvement, area of newly added forests/woodlands, forest stockpile, size of forests returned from farmlands, etc.
	Farmlands: farmland protection and soil contamination remediation	Size of cultivated land for restoration, construction area of high-standard basic farmland, size of cultivated land for improvement, size of newly added cultivated land, safe utilization rate of contaminated farmland/plots, etc.
	Grasslands: grassland conservation and desert management	Size of grassland for ecological protection, restoration and remediation, size of newly increased forest and grassland for restoration, size of newly increased grassland, newly added area of degraded grassland for improvement and restoration, vegetation coverage ratio of grasslands, etc.

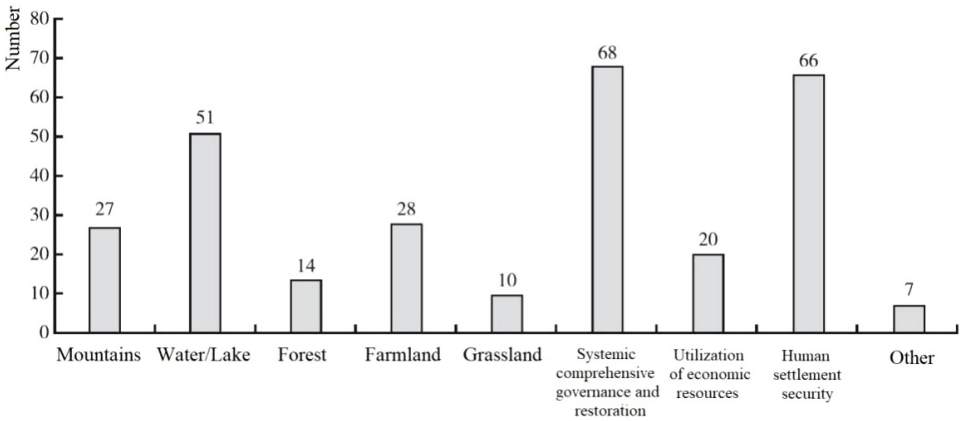
Table 1. (*Continued*)

Dimension	Synergy elements	Examples of key indicators
	Systemic comprehensive governance and restoration: soil erosion control, habitat restoration and biodiversity conservation	Soil erosion control: ratio of ecological red line area to national land areas, surface subsidence and geological disaster area for comprehensive governance, area size/quantity of mine environment for comprehensive governance, ratio of farmland restoration in mining areas with serious ground subsidence, area of land remediation, reduced soil erosion area, soil erosion control rate, area of rocky desertification remediation, etc. Habitat restoration: comprehensive treatment area of river ditch slope, ecological restoration project area of shoreline, restoration rate of wharf shoreline, wetland restoration and construction area, length of river for ecological restoration, new area of restored artificial wetland, length of new seawall protection, amount of ecological water supplement/water level restoration, natural wetland protection rate, upstream water conservation area, area of forest and grassland returned from farmland/afforestation/forest tending, reduced area of groundwater over-exploitation, groundwater level/quality, etc. Biodiversity protection: degradation trends of endangered animals and plants, protected areas of geological parks and relics, watershed biodiversity protection indexes, area of wildlife protection projects, protection rate of key protected wild animals and plants, etc.
Broad synergy	Economic goods and services provision and resources utilization	Utilization rate of water resources, coverage rate of green technology for prevention and control of crop diseases and insect pests, utilization rate of chemical fertilizers/pesticides, recovery rate of waste mulch film in farmland, comprehensive utilization rate of crop straw, comprehensive utilization rate of livestock and poultry manure resources, recycling rate of wastewater from aquaculture, recycling rate of agricultural input packaging, etc.
	Human settlement security	Ecological environment monitoring and early warning capabilities, the number of geological disaster prevention and control projects, the number of hidden geological disasters, the number of dismantled hydropower stations, the number of closed, remodeled and relocated enterprises, the water quality compliance rate of urban and rural centralized drinking water sources, the rate of solving drinking water difficulties, the diversion and transformation of urban rain and sewage, proportion of odorous water bodies in urban built-up areas, urban/rural sewage treatment rate, coverage rate of urban and rural household waste classification and collection, number of villages for human settlement environment improvement, fertilizer/pesticide usage on main crops, industrial wastewater discharge rate, compliance rate of pollutants discharged by ships, etc.
	Other development goals	Progress of national eco-civilization construction demonstration zones, the number of ecological immigrant households, the number of villages out of poverty, the number of people lifted out of poverty in advance, the per capita disposable income of rural residents, etc.

Source: "Notice of the Ministry of Finance on the Issuance of the 2017 Special Funds Budget for Key Ecological Protection and Restoration Governance", available at: http://jjs.mof.gov.cn/zxzyzf/gyxdzgzzxzj/201801/t20180104_2792739.htm; and "Notice of the Ministry of Finance on the Issuance of the 2018 Special Funds Budget for Key Ecological Protection and Restoration Governance", available at: http://jjs.mof.gov.cn/zxzyzf/gyxdzgzzxzj/201812/t20181213_3092653.htm.

ecological elements in narrow synergy dimension correspond to the following governance contents: (1) mountains, i.e. mining environmental management and restoration; (2) water/lakes, i.e. rivers, lakes and watershed environmental protection and management; (3) forests, i.e. forest protection and quality improvement; (4) farmlands, i.e. farmland protection and soil pollution remediation; (5) grasslands, i.e. grassland protection and desert management; and (6) comprehensive system management and restoration, i.e. soil erosion control, habitat restoration and biodiversity protection. According to *Notice on Promoting the Ecological Protection and Restoration of Mountains, Rivers, Forests, Farmlands and Lake*s, the holistic, systematic and comprehensive governance and restoration means "in areas with abundant ecosystem types, wetlands, grasslands and woodlands are integrated into major projects to restore and comprehensively remedy contiguous, severely fragmented and functionally degraded ecosystems. The government will gradually restore the functions of the ecosystem by means of land remediation, vegetation restoration, river–lake–marsh connection, shoreline environment governance, and wildlife habitat restoration, etc." The governance content at the broad synergy dimension includes: (1) economic goods and services provision and resource utilization; (2) habitat security; and (3) other development goals.

According to the classification in Table 1, the statistical results of the indicators of the 16 pilot projects are shown in Fig. 2. These pilot provinces design the projects based on local conditions by referring to the five major contents. Most of them focus on the governance of mineral mountains, land remediation and watershed environment management. Among all the projects, only three provinces explicitly mention "comprehensive remediation" in the name of the pilot projects, including "comprehensive water environment remediation" in Fujian, "mine rehabilitation and comprehensive land remediation" in Shanxi and "comprehensive watershed environment restoration" in Inner Mongolia. However, in the design of specific project construction performance indicators, to various degrees, the pilot projects have incorporated indicators reflecting systematic and comprehensive governance, such as soil erosion control, habitat restoration, biodiversity



Source: Made by the authors.

Fig. 2. Number of performance indicators for each synergistic governance element of pilot projects.

conservation, etc. Some pilots have designed special projects for this purpose. For instance, Heilongjiang, Jilin, Sichuan, Guangdong, Hunan, Yunnan, Fujian and other pilot provinces have designed special projects for habitat restoration and biodiversity conservation, which combine biodiversity conservation with wetland restoration, forest cultivation, lake restoration, water conservation, soil erosion control, etc. In terms of specific comprehensive governance indicators, even for special projects, indicators are still rare to measure the performance of biodiversity conservation. On the one hand, this indicates that the fundamental work of ecological restoration and habitat restoration has not yet been completed. On the other hand, it may be due to the insufficient understanding of and attention of local authorities to the significance of biodiversity conservation in ecosystem governance, and there is still a long way to go from habitat restoration to biodiversity conservation.

Some pilot projects have expanded the connotation of holistic, systematic and comprehensive governance and restoration, and included such development goals as urban and rural habitat governance, national eco-civilization construction zones, ecological migration and poverty alleviation. For example, Guangdong has designed the special project of "watershed protection and local residents' quality of life". Hubei put forward the pilot project of "improvement of the quality of human habitat" with specific indicators such as domestic wastewater treatment rate and harmless treatment rate of domestic garbage. Sichuan has incorporated the goal of eliminating poverty and poor villages into the performance indicators of the special project of local residents' quality of life. Xinjiang designed the pilot project of "human habitats", and the performance indicators include the number of ecological immigrant households, ecological environment monitoring and early warning capabilities, the number of national eco-civilization demonstration zones passing national audit, etc. The expert review of the implementation plans for the 10 pilot projects in 2018 was also consistent with the idea of "systemic governance" in a broad sense. For example, it was suggested that some pilot provinces and cities "take advantages of natural resource endowments, promote ecological industrialization according to local conditions, and increase the output of high-quality ecological products", "coordinate ecological migration and ecological protection", "integrally advance and coordinate poverty alleviation, resource-based economic transformation, and cultural protection of the old revolutionary base areas", "integrally consider improving the functions of production, living and ecological spaces" and so on.[1]

Some pilot provinces highlighted the strategic significance of the projects for national ecological security in their overall objectives. For instance, Hunan Xiangjiang River Basin and Dongting Lake Ecological Protection and Restoration Project proposed to invest 7.913 billion yuan, aiming for the ecological protection and restoration of one river and one lake, which includes four types of projects with 20 sub-projects, so as to create a "Clearwater Corridor" and build a firm ecological barrier for the Yangtze River Economic Belt and the

[1] "Review and Suggestions for the Implementation Plan of the 3rd Batch of Mountains, Rivers, Forests, Farmlands, Lakes and Grasslands Ecological Protection and Restoration Projects (Distributed to local governments)", Appendix 4 of "Notice of the Ministry of Finance on the Issuance of the 2018 Special Funds Budget for Key Ecological Protection and Restoration Governance", available at: http://jjs.mof.gov.cn/zxzyzf/gyxdzgzzxzj/201812/t20181213_3092653.htm.

central part of the country; Xinjiang proposed "ensuring ecological security of water towers in the northern Xinjiang and creating an ecological civilization demonstration area for the Silk Road Economic Belt"; Chongqing proposed "building a firm ecological barrier for the Upper Reaches of the Yangtze River"; Inner Mongolia proposed "building an important ecological barrier in the northern China and enhancing the ecosystem service function of the 'Northern Sand-control Belt'"; Heilongjiang focused on its role in safeguarding national ecological security and food security; and Guangxi emphasized rocky desertification remediation, mining pollution and heavy metal contaminated soils remediation. In addition, some western pilot provinces explicitly included poverty reduction in their overall objectives. For examples, Shanxi Province proposed to "promote ecological poverty alleviation in the Lvliang Mountains which have contiguous areas of absolute poverty", and Sichuan Province proposed to "realize the ecological development of regional industries and the removal of poverty from the poor population as scheduled".

4.2. *Suggestions to promote the systemic governance of the MRFFLG*

The construction of a comprehensive governance system of the MRFFLG requires overall planning, holistic implementation and multiple solutions simultaneously, so as to strengthen the synergistic and systemic governance in objectives, fields and approaches. Compared with foreign watershed management and ecological planning, which often take decades, the implementation cycle of our pilot projects was only three years, and the project design and construction was not systematic and enduring. Post-pilot maintenance and sustainability management was short of consideration (Yang *et al.*, 2020). In order to meet the requirements of ecological civilization construction, in January 2020, the Ministry of Natural Resources issued the *General Plan for the Construction of the Natural Resources Survey and Monitoring System*, which aims to strengthen collaborative governance in terms of the function and structure of the system of the MRFFLG. In September 2020, the MNR, the MOF and the MEE formulated *Guidelines for Ecological Protection and Restoration of the MRFFLG (Trial Version)*, which guides and regulates regions to promote holistic protection, systematic restoration and comprehensive management of the MRFFLG in terms of elements, measures, engineering construction, objectives, benefits, etc. The *Guidelines* requires "the adoption of engineering, technical, biological and other measures... to optimize national territory spatial planning, improve the resilience of the social-economic-natural complex ecosystem, comprehensively improve the quality of the national and regional ecological security barriers, and promote the virtuous cycle and sustainable use of ecosystems".

The fifth plenary session of the 19th CPC Central Committee adopted *The Formulation of the 14th Five-Year Plan (2021–2025) for National Economic and Social Development and the Long-Range Objectives Through the Year 2035*. It clearly put forward the goals that by 2035 "...Eco-friendly work and lifestyle will be advanced to cover all areas of society... there will be a fundamental improvement in the environment after the goal of building a Beautiful China is met". In response to the above objectives and requirements, local governments would further strengthen the construction of ecological civilization

during the 14th Five-Year Plan period. The systemic governance of the MRFFLG is the material and resource environment foundation to promote the construction of Beautiful China. Therefore, based on the concept of narrow and broad synergies, the following aspects should be strengthened in project design and construction.

First, coordinated planning should be strengthened so that the narrow synergy dovetails with the broad synergy. For example, engineering measures and non-engineering measures should be combined with each other, drawing on foreign advanced concepts and practices such as green infrastructure and adaptive ecosystem management, giving priority to natural ecological restoration techniques that are of low cost, provide high yield and have long-term mechanisms; attention should be paid to the improvement of project investment benefits and ecosystem functions and quality, rather than simply taking the increase in the quantity of ecological elements like forest coverage as the assessment indicator. Pollution remediation should be combined together with ecological protection, focusing on the synergistic control of pollution in the watershed and upstream and downstream of the industry, and exploring the circular economy and eco-efficient projects with greater ecological dividends and people's welfare; a cross-departmental, cross-provincial and municipal coordination mechanism should be put in place, establishing information- and data-sharing mechanisms and platforms, breaking the boundaries of administrative divisions, industry management and ecological elements, exploring mechanism innovation, etc.

Second, the goals of addressing climate change should be incorporated into the systemic governance of the MRFFLG. The original purpose of the pilot work is to strengthen the ecological restoration of national territory space by providing subsidies to projects with good results in the early stage, encouraging local innovations and providing cases to enrich the concept of ecological civilization in China. For example, some arid western regions in China with severe soil erosion have achieved goals of watershed governance, barren mountain remediation, soil and water conservation and ecological protection along with poverty eradication and economic development, through government-led projects such as returning farmland to forests, ecological migration, precise poverty alleviation and ecological restoration of the MRFFLG (Cai *et al.*, 2020). In the context of climate change, ecological construction helps increase the area of forests, grasslands and wetlands, enhances carbon sink storage, and contributes to carbon neutrality targets. At the same time, key support for ecologically fragile areas should be strengthened, taking the MRFFLG pilot construction as a coordinated approach for less-developed regions in central and western China to cope with climate poverty, explore ecological dividends and industries and enhance high-quality development and new urbanization.

Third, the concept of the MRFFLG life community should be extended to the marine field, strengthening the integrated governance of land and sea. The General Secretary Xi Jinping in April 2019 proposed the concept of "maritime community with shared future", stating that the ocean nurtures life, connects the world and promotes development. The concept of maritime community with shared future implies the relationship between human beings and marine ecological protection, and that between marine governance and sustainable development. The 12th Five-Year Plan put forward a land–sea integrated marine development strategy. China has 18,000 km of mainland coastline, while coastal areas

accommodate more than half of the country's population and 60% of GNP value. *The 2019 China Marine Economy Statistical Bulletin* showed that China's marine economy grew rapidly and had accounted for 17% of GNP in the coastal areas, including fishing, marine aquaculture, shipbuilding and maritime transportation, travel and leisure industry, etc. At the same time, however, the continuing deterioration of the marine environment has destroyed more than half of China's coastal wetlands and habitats (CCICED, 2020). In the future, China should attach great attention to the synergistic governance of land and sea ecosystems in coastal areas, and clearly advocate the concept of land–sea systemic governance of mountains, rivers, forests, farmlands, lakes, grasslands and seas (MRFFLGS).

4.3. *The practical path of systemic governance of the MRFFLG*

China's rapid urbanization and economic development over the past 40 years have continued to aggravate the degradation of the ecosystem, and there is still a big gap to fulfill the requirements of ecological security, environmental friendliness and sustainability of resources for the construction of ecological civilization. Of China's land area, the ecologically sensitive area accounts for 40.6%; ecologically fragile area accounts for more than 60%; and the total desertification area accounts for about 27%. The per-capita forest cover is only 1/4 of the world's per capita. These have led to a serious lack of ecological service functions and high-quality ecological products (Cai *et al.*, 2020). The systemic governance of the MRFFLG not only helps restore and enhance the natural capital, but also improve human habitats and social well-being, and solidify the material foundation for the construction of ecological civilization. In the future, combined with China's strategic goals of addressing global climate change and green development transformation, it should be promoted from two dimensions of synergy.

(i) *The narrow synergy pathway: Enhancing ecosystem services and climate resilience*

Ecosystems are self-regulating. In general, the richer the biodiversity of the ecosystem, the more complex the structure, the higher the productivity, the stronger the ability of anti-disturbance and resilience and the more stable the system. However, human-induced climate change often exceeds the adaptive boundaries of ecosystems. Under the combined influence of climate change and human activities, ecological risks such as desertification, soil erosion, rocky desertification, salinization and permafrost degradation have intensified, requiring man-made management measures to enhance the adaptability of natural ecosystems. For examples, by 2050, climate change will put 5–30% of animal species and 10–20% of wild plants at high risk of endangerment; the suitable habitat areas of the endemic and endangered species of giant panda and Sichuan golden monkey will be reduced by 1/3 and more than 1/2, respectively (Wu *et al.*, 2017). In this regard, ecological restoration and climate adaptive actions in key watersheds, ecological safety zones, and major national strategic development areas should be strengthened during the 14th Five-Year Plan period. For hot areas of biodiversity such as Yunnan, Guizhou and Sanjiangyuan, or areas with unique and rare species such as giant pandas and northeastern tiger habitats, innovative pilots like national parks and state- or provincial-level ecological

civilization demonstration zones should be encouraged and supported, so as to change from engineering governance in the pilots to comprehensive governance of the whole system.

Adaptive management measures for ecosystems include ecological restoration, land and mine remediation, coastal zone management, habitat protection for endangered species, ecological carrying capacity limit, forage–livestock balance, conservation tillage technology and natural resources property rights. From the analysis of domestic documentation and international experience, small watershed governance is an important entry point for ecological restoration and whole-basin management based on the ecosystem approach (Zhong *et al.*, 2020). In terms of local pilots, 8 of the 25 projects belong to important river and lake basins, including pilots in Min River Basin (Fujian), Zuoyou River Basin (Guangxi), Fuxian Lake (Yunnan), Wuliangsuhai Basin (Inner Mongolia), Xiangjiang River Basin and Dongting Lake District (Hunan), Lhasa River Basin (Xizang), Irtysh River Basin (Xinjiang) and the upper and middle reaches of the Fen River (Shanxi); six projects have integrated the management of important watersheds and mountain landscape environment. The projects are the Beijing–Tianjin–Hebei Water Conservation Area, the Xiaoxinganling–Sanjiangyuan Plain in Heilongjiang, the source of the Qiantang River in Zhejiang, the confluence of Helan Mountain and the Yellow River in Ningxia, the Three Gorges area of the Yangtze River in Hubei and the upper reaches of the Yangtze River (Chongqing Section) (Yang *et al.*, 2020). Adaptive management of small watersheds comprehensively considers different scenarios such as onshore and offshore, upstream and downstream, and urban and rural areas. For example, in response to serious water pollution caused by urbanization and industrialization, Beijing has been actively promoting small watershed management since 2010, combining engineering, farming and management measures, exploring and applying the technologies of rural rainwater utilization, near-nature water management, wetland water quality and ecological protection, which significantly improved water security and urban environment.

(ii) *The broad synergy pathway: Exploring ecological dividends and developing ecological economy*

During the 14th Five-Year Plan period, local governments should take the opportunity to build ecological civilization and Beautiful China, promote green urbanization according to local conditions, and incorporate green infrastructure and natural capital investment into urban and rural development planning and ecological spatial planning. The protection and restoration of the life community of the MRFFLG is an important way to tap the ecological dividends and improve people's well-being. For example, Longde of Ningxia Province integrated funds from relevant departments such as agriculture and animal husbandry, forestry, land, water affairs, agricultural development and other related departments, and adopted comprehensive measures such as pollution interception and control, reservoir governance, soil and water conservation, water-saving transformation, ecological restoration, law enforcement, supervision, etc. to control pollution in the Yu River Watershed, so that the water quality of the outbound section of the watershed changed from worse than Grade V to Grade IV. At the same time, the development of ecological agroforestry would help alleviate poverty (Du and Liu, 2018; Meng, 2018). Ganzhou of

Jiangxi Province, one of the first batch of pilot cities, promoted a narrow synergy model of "coordinated governance up and down the mountains, below and above the ground, and upstream and downstream of the basins", and explored a broad synergy model of "ecology + precise poverty alleviation" and "ecology + rural revitalization", combining the transformation of low-quality and low-efficiency forest reconstruction with precise poverty alleviation. Developing eco-tourism or agritourism through village renovation, it promoted poverty alleviation of poor households, and utilized ecological resources to develop the economy (Wu and Xie, 2018). In addition, Shuozhou City in Shanxi Province considered "mountain" as an important conservation area in the MRFFLG system. Starting from key links of cultivated land protection, water resources protection, mine environment restoration and governance, land reclamation and remediation, and forest and grass co-governance, it explored socio-ecological approaches to improve complex habitats in mining areas, aiming to help resource-dependent cities in getting rid of resource constraints and achieve transformation (Kong and Ma, 2018).

With the aim of giving priority to ecology and comprehensive protection, China has been vigorously strengthening ecological construction from the Central Government to the local governments, and has achieved a double gain in both ecological and economic benefits. For example, after 56 years of afforestation in Saihanba of Hebei Province, the forest coverage rate has reached 80%. According to the assessment of the Chinese Academy of Forestry, the total resource input-to-output ratio of Saihanba is 1:19.8. Every year, the forest ecosystem can conserve and purify 137 million m^3 of water, sequester 747,000 tons of carbon, release 545,000 tons of oxygen and provide ecological services with values exceeding 12 billion yuan. Saihanba National Forest Park attracts more than 500,000 tourists every year, and the annual ticket revenue is more than 40 million yuan. The total emissions reduced by the forests are 4.75 million tons of CO_2 equivalents, and the forest carbon sink potential can reach hundreds of millions of yuan (Wei, 2017).

5. Conclusion

The shared life community of the MRFFLG contains rich connotations and environmental value, and it is a conceptual framework that is both scientific and theoretical.

Based on the theory of complex socio-ecological systems, this paper proposes two synergy dimensions of the MRFFLG systemic governance. It compares and evaluates the engineering construction plans of some pilot projects, which help provide reference for local governments to promote relevant pilot projects in the 14th Five-Year Plan period. The systemic governance of the MRFFLG has a process from concept to practice. In the future, it should promote multi-objective, multi-field and multi-action coordinated governance as pathways. The first is a narrow synergy pathway which primarily aims to restore the service functions of the ecosystem in the complex socio-ecological systems. From the perspective of natural resources management, ecological protection and restoration, China should focus on strengthening the coordinated governance of ecological and environmental elements. The second is the broad synergy pathway aiming at building a human–nature community of shared life. China should take ecosystem restoration and protection as the

basic work for improving natural capital, and incorporate ecosystem concepts, technologies and methods into the transformation to green development, such as new urbanization, ecological civilization pilot demonstration, rural revitalization and construction of Beautiful China. It should be pointed out that this paper focuses on the design plan and performance assessment indicators of the pilot project, aiming to provide top-level design and evaluation indexes for subsequent pilot projects. Under the overall goal of eco-civilization construction, future research may focus on how to integrate the system of the MRFFLG into urban and rural development planning, precise poverty alleviation, construction of new countryside, sponge cities, low-carbon urbanization, etc. and summarize and refine collaborative and innovative mechanisms in practice.

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