COMMENTARY

Ecosystem quality-based management and the development of a new eco-friendly economy

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A harmonious "nature–society–economy" system can improve human welfare if ecological products are valued and an ecologically self-aware economy is created. Natural ecosystems provide abundant, high-quality ecological products, as well as stable and sustainable ecological services for the Earth's life support system. Maintaining healthy, functional environments can facilitate the survival and development of human societies.[1] In the previous era of agricultural civilization, agricultural products and handicrafts were the main commodities, and the agricultural economy determined socioeconomic development. Since the Industrial Revolution, the production, circulation, trade, and application of products related to industry, including machines, steel, and coal, have resulted in the agricultural economy gradually being replaced with the industrial economy. With information technology development, electronic products and e-commerce, as well as other new economic products and relationships, have become the most important part of the social economy. However, traditional industrial production and industrial economic development are impacted by limited resources and strict environmental protections. To improve the quality and stability of the Earth's ecosystem, we must construct a new economic form that prioritizes ecological issues and green development.

Natural capital has become a major bottleneck in economic development, and ecological products have become scarce goods. Not only do humans benefit from the products, services, functions, and overall value of a given ecosystem, but humans are also capable of managing and intervening in this ecosystem. However, the increasing diversification and intensity of human activities have affected the structure, processes, and functions of ecosystems, as well as the subjective degree of satisfaction that people have with these ecosystems, including the sustainability of harvesting products and using services. The trade-off between development for human needs and the biosphere's ability to provide products and services in a stable manner is becoming increasingly prominent,[2] and the challenge of achieving sustainable development remains daunting. Therefore, it is necessary to develop ecological products, ecological industries, and an ecological economy in line with ecological concepts to systematically solve both environmental problems and the contradictions of social development and to ensure the harmonious coexistence of humans and nature.

A new eco-friendly economic path can be developed to address these environmental, social, and economic issues. The foundation for the development of the new eco-friendly economy is the change from artificially designing and creating ecological products to expanding the applications of ecological products with ecological attributes. Developing a new eco-friendly economy may involve reshaping economic structures by producing products with ecological attributes and by designing and creating industrial systems based on ecological ideas. This new eco-friendly economy can give ecosystem products and services new economic value based on the needs of an industrialized human society while still ensuring that development remains within the carrying capacity of the ecosystem. Therefore, the new eco-friendly economy could continuously improve the quality of the "nature-society-economy" system and promote the coupling and sustainable development of the human-Earth system. This is the best way to achieve high-quality social and economic development, build a solid ecological safety system, and promote green development.

New eco-friendly economic systems should be consistent with ecological and economic regulations. The "theory-net-system" framework has been proposed to express the Chinese path of harmonious coexistence between humans and nature. The quality and stability of ecosystems are the basis of developing a new eco-friendly economy. The six most important ecological theories are (1) the self-organization of biological agglomeration and structural nesting, (2) the correlation of ecological elements and the coupling of ecological processes, (3) ecosystem integrity and function emergence, (4) ecological service spillover and efficiency trade-off, (5) the synergy and interactions between resource supply capacity and environmental suitability, and (6) the interaction between spontaneous change and human activities. Overall, the ecosystem component-structure-process-function-service relationship and factor-system-environment feedback can help us better understand the co-evolution of ecosystem quality and stability. The three relevant networks are the "nature-nature" cascade co-generation network, the "human-human" social action network, and the "human-nature" interaction network. Ecological theories and ecological technological systems can optimize the "nature-nature" cascade co-generation network to improve ecosystem quality and stability. An innovative industrial system can promote social action through the reasonable accounting and assignment of ecological assets and capital as well as the circulation and trading of ecological products and services. An advanced market system can coordinate the effective supply of the ecosystem with the developmental needs of human societies based on the "human-nature" interaction network (Figure 1).

Note: ecosystem-quality-based management and the development of a new eco-friendly economy involve six important ecological theories, three networks, and three systems. Ecosystem quality management mainly includes nature-nature network optimization and technological system construction based on the ecological theories of agglomeration and nesting, correlation and coupling, integrity and emergence, and spillover and trade-off. The ecosystem provides the resources and a suitable environment for human society, while human activities and spontaneous change affect ecosystem quality and stability. The market system and "human-nature" interaction network create the linkage between the ecosystem and human well-being. The industrial system meets the demands of human social development and strengthens the "human-human" social action network. The market system and industrial system together promote the development of a new eco-friendly economy.

The development of this eco-friendly economy will involve various management subjects, such as land use, industrial development, and the consideration of economic levels. The paradigm of "multidisciplinary cognition, multiobjective application, multiagent collaboration, and multiprocess coupling" should be adopted to strengthen ecological protection and ecosystem restoration programs, improve the objective quality of the ecosystem, meet growing demand, and achieve the high subjective quality of the ecosystem. Specifically, the coupling of the processes of material production, recycling, energy flow, and information transmission can be realized by comprehensively applying ecology, economics, earth system science, and other theories and methods, focusing on multiapplication goals such as ecosystem operation and management, comprehensive ecological environment management, regional sustainable development, and the response to global environmental change, and by relying on government leadership, social participation, and public supervision. In addition, we must coordinate social development and ecological protection goals and adjust our demand structure to suit the development of human society and improve the efficiency of resource utilization. Furthermore, we must improve the quality and stability of the ecosystem and fully consider the carrying capacity of regional resources and

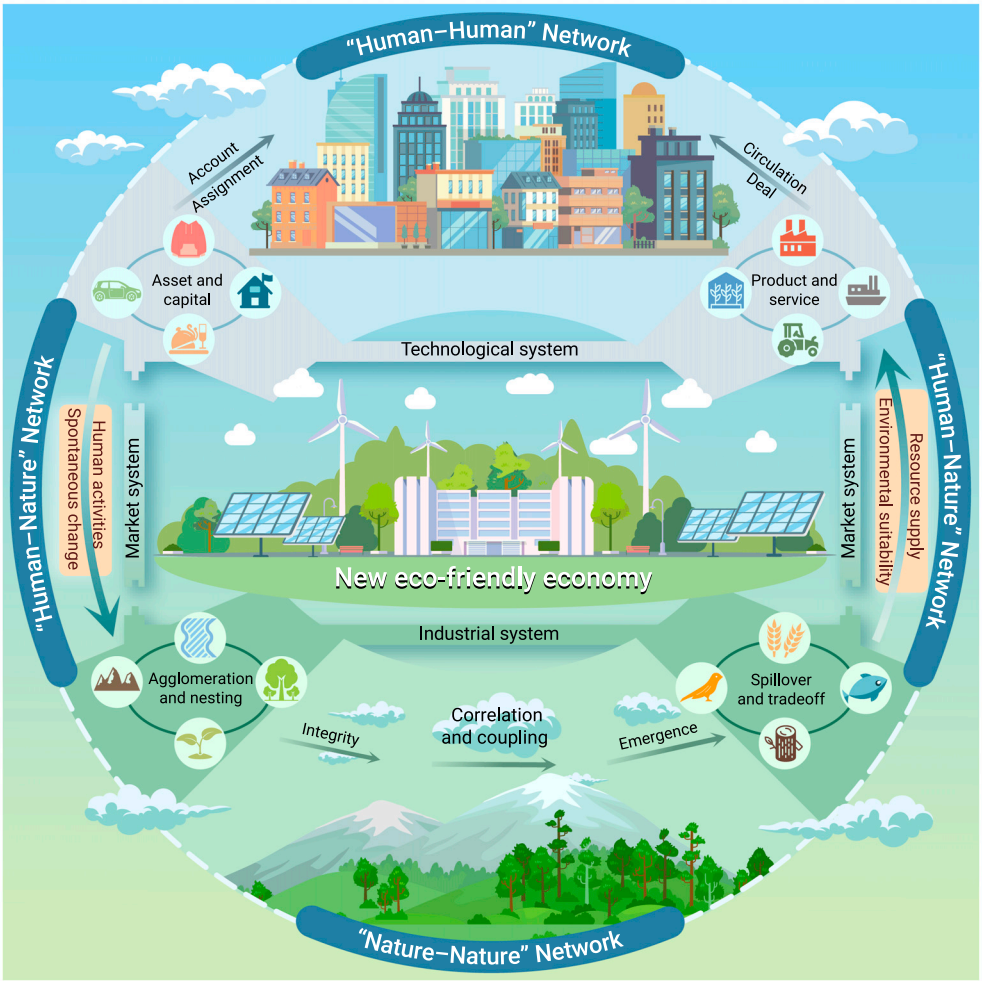

Figure 1. Six theory-three network-three system (6T-3N-3S) framework of ecosystem quality improvement and a new eco-friendly economy

the capacity of the ecological environment, as well as the rational protection, utilization, restoration, and reconstruction of natural ecosystems to maintain their versatility, authenticity, integrity, complexity, adaptability, and stability, in addition to enhancing their stock value and flow supply level.

China's ecological civilization cannot be built without this new type of eco-friendly economy, which is closely linked to the systems of an ecological civilization and ecological security. The ecological economy provides a material foundation for sustainable development, while the ecological civilization provides a strategy and policy support. Ecological security can be used to develop a new type of eco-friendly economy and create an ecologically balanced civilization. Based on the ecological civilization concept of "harmonious coexistence between humans and nature" and the economic idea that "lucid waters and lush mountains are invaluable assets," the Chinese government has carried out innovative ecological engineering and scientific practices to improve the quality and stability of the ecosystem to meet people's ever-growing needs for a better life. For example, China's ecosystem restoration projects not only restore species diversity and ecosystem functions but also improve human well-being.[3] After actively investing in protecting and restoring natural capital, not only has China seen great improvements in ecosystem services[4] and notable increases in the ecosystem quality of most counties,[5] but it has also partially realized a win-win effect with respect to environmental protection and economic development.

New eco-friendly industries have quickly developed in various fields, such as transportation, construction, and new energy, and they will become the nation's dominant industries. With the continuous growth in new eco-friendly economic activities, the ecological industry will become central to the national economy. Ultimately, the new eco-friendly economy will reshape the social economy through its input in the early stage of ecological civilization construction by generating income during the process of ecological civilization construction and by increasing the economic value of ecological products and services after the completion of ecological civilization construction. China aspires to become a modern nation by 2050. The traditional economic growth model can no longer support the achievement of this goal. The new eco-friendly economy provides strategic decision-making and a path for green development for China's 2050 modernization goal.

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DECLARATION OF INTERESTS

The authors declare no competing interests.