

The Concept of Soil and Water Ecology is the Wisdom and Science for Building a Beautiful China

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Abstract Based on modern science, the concept of soil and water ecology creatively transforms and develops traditional ecological wisdom. The scientific value of the soil and water ecological concept is reflected in its explanatory power for phenomena, revelation power for laws, and leadership power for future research, and manifested in revealing the essence of ecological and environmental problems and constructing a unified ecological theory paradigm; tropical rainforests and cold coniferous forests may seem very different, but they are both the result of mutual adaptation of soil, water, and vegetation under specific hydrothermal conditions; although there are significant differences in structure and function between natural ecosystems and artificial ecosystems, they both follow the basic laws of mutual constraint among water, soil, and vegetation. The theoretical penetrating power of "simplifying complexity" in the concept of soil and water ecology is precisely where its scientific value lies. The important practical significance of the soil and water ecological concept lies in guiding ecological protection and restoration work, providing theoretical support for ecological civilization construction, and contributing Chinese wisdom to global environmental governance. Eight core innovations in the theory of soil and water ecology are: ① defining for the first time the independent scientific category of "soil and water ecology"; ② ecology, environment, and resources are the unified theory of "three aspects in one"; ③ reconstructing the underlying attribution of global ecological issues; ④ proposing from soil and water conservation 1.0 to soil and water ecological conservation 2.0; ⑤ constructing a complete evolution gradient of soil and water ecological balance – degradation; ⑥ establishing an independent disciplinary system for soil and water ecology; ⑦ reconstructing the logic of harmonious coexistence between humans and nature; ⑧ coordinating new ideas for ecological governance, addressing the shortcomings of water conservancy, forestry, agriculture, and natural resource management, and proposing a comprehensive integrated governance model for soil and water ecology across the entire region, and a top-level institutional planning concept, to promote the shift from single soil erosion control to overall soil and water ecological management and protection of national land space.

Key words Concept of soil and water ecology; Beautiful China; Wisdom and science; Scientific value; Practical significance; Core innovation

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The theory of soil and water ecology is a common theoretical foundation in the field of ecological environment, and soil and water ecology is the cornerstone of ecological civilization and sustainable development^[1–2]. The concept of soil and water ecology is the deepening and development of the cognitive concept of soil and water conservation, as well as the innovation and expansion of ecological science. Narrowly defined, it refers to the ecological balance relationship among water, soil, and vegetation. Broadly defined, it refers to the sum of all relationships among water, soil, and vegetation in the process of movement and evolution. It is a modern scientific theory that re-examines the ecological environment from the perspectives of systems theory and philosophy. It summarizes complex ecological problems into three core elements: water, soil, and vegetation, and their interrelationships. By grasping the key elements of water, soil, and vegetation, it grasps the essence of complex ecological problems and provides new ideas for fundamentally solving ecological crises. The concept of soil and water ecology is not only a scientific cognition, but also a worldview and methodology with profound cultural connotations. It is rooted in the ecological wisdom of "unity of heaven and humanity" in the Chinese civilization, and transcends Western environmental

protection concepts, providing a new philosophical perspective and value orientation for the sustainable development of human civilization.

1 The concept of soil and water ecology is a modern scientific expression of traditional Chinese wisdom

Chinese civilization is the only ancient civilization in the world that has lasted for thousands of years without interruption, and its profound ecological wisdom provides a rich source of ideas for contemporary concept of soil and water ecology. At the same time, the concept of soil and water ecology is based on modern science and has creatively transformed and innovatively developed traditional ecological wisdom.

1.1 Traditional Chinese wisdom on soil and water In the fields of agriculture, forestry, animal husbandry, water conservancy, *etc.*, our ancestors accumulated rich experience in soil and water management, and a unique concept of soil and water was formed^[3].

1.1.1 "Water conservancy" and "water hazards". In ancient China, water was regarded as both "benefit" and "harm". "Water can carry a boat, but it can also capsize a boat" is not only a political metaphor, but also a profound understanding of hydrological relationships. The legend of Dayu's flood control embodies the

wisdom of turning "blocking" into "dredging" in water management, not to confront water, but to guide it according to its nature. These water concepts are highly consistent with contemporary water resource management concepts, reducing flood risks and enhancing social resilience to disasters through spatial planning, ecological restoration, and other means.

1.1.2 "Land fertility" and "land suitability". Traditional Chinese agriculture emphasizes the constant renewal of soil fertility through measures such as crop rotation, fertilization, and deep plowing, in order to maintain and improve soil fertility, rather than "draining the pond and fishing". The *Rites of Zhou · Offices of the Earth* proposes to "distinguish the products and names on twelve different types of land according to the principle of identifying land suitability, to survey the residential sites of the people, clarify the advantages and disadvantages of the land on human habitation, achieve population reproduction, bird and animal breeding, and vegetation growth, and carry out various land production tasks reasonably". It emphasizes adapting to local conditions and arranging suitable crops and land use methods according to the nature of the soil.

1.1.3 "Seasonal prohibition and allowance". The *Mencius · King Hui of Liang* (Part I) proposes that "if axes are allowed in the mountains only in proper seasons, timber will be inexhaustible", emphasizing that logging should follow the season and be prohibited during the growth period of plants and trees. This ancient system of "seasonal prohibition and allowance" reflects respect for the regenerative capacity of vegetation. These traditional wisdom have important implications for contemporary forest management. The core of sustainable forestry is to control the logging volume within the growth rate and the utilization intensity within the regenerative capacity.

1.1.4 "Mulberry-base fishpond". The circular agriculture model of "mulberry-base fishpond" in the Pearl River Delta is a model of traditional comprehensive utilization of water and soil. Mulberry leaves are used to raise silkworms, silkworm excrement is fed to fish, fish manure is used to fertilize ponds, and pond mud is used to fertilize mulberry trees (Fig. 1), forming a material cycle system among "water – soil – vegetation – animal", and achieving multi-level utilization of resources and zero discharge of waste. This traditional wisdom has important enlightening significance for the development of contemporary circular economy and ecological agriculture.

1.2 The concept of soil and water ecology is a creative transformation and innovative development of traditional wisdom The combination of soil and water ecological concept and traditional soil and water concepts is conducive to the construction and dissemination of ecological civilization, making the scientific concept of "lucid waters and lush mountains are invaluable assets" richer in Chinese cultural heritage.

1.2.1 Philosophical level. The traditional concept of "unity of heaven and humanity" provides a profound philosophical foundation for the concept of soil and water ecology, while the concept of

soil and water ecology provides modern scientific evidence for the concept of "unity of heaven and humanity". The coupling relationship among water, soil, and vegetation reveals the scientific foundation of the inherent unity between humans and nature. The combination of traditional wisdom and modern science enables harmonious coexistence between humans and nature, with both philosophical and scientific support.

1.2.2 Theoretical level. The traditional concept of soil and water can be mutually confirmed with the theory of soil and water ecology. The profound insights in traditional concepts can be scientifically explained in modern ecology; the rigor of modern science enables traditional wisdom to be precise and systematic.

1.2.3 Practical level. Traditional ecological wisdom provides technical prototypes that can be used for reference for contemporary soil and water ecological protection, restoration, and utilization. These traditional technologies have been proven to be sustainable in long-term practice. In today's applications, their ecological logic needs to be preserved, and their technological forms needs to be updated. For example, ecological cycle models such as "mulberry-base fishpond", "rice – fish – duck", and "pig – biomass – fruit" can be upgraded to modern ecological agricultural parks.

1.2.4 Cultural level. The excavation and promotion of traditional soil and water concepts can help enhance the ecological awareness of the whole society^[4]. The values of respecting, conforming to, and protecting nature in traditional culture are more easily understood and accepted by the public than the "environmental protection" introduced from the West.

2 Scientific values of the concept of soil and water ecology

The scientific value of the concept of soil and water ecology is reflected in its explanatory power for phenomena, revelation power for laws, and leadership power for future research.

2.1 Revealing the essence of ecological environment problems For a long time, hydrologists have focused on the water cycle, soil scientists on soil erosion and fertility, ecologists on biodiversity and community succession, and environmental scientists on the migration and transformation of pollutants. As a result, people often "see trees but not forests", making it difficult to grasp the overall essence of ecological and environmental issues.

The concept of soil and water ecology holds that the root cause of all ecological and environmental problems can be attributed to the imbalance of the relationship among the three major elements of water, soil, and vegetation^[5]. Whether it is desertification, soil erosion, sharp decline in biodiversity, climate change, urban heat island effect, or non-point source pollution, there is always a problem of imbalance in the water – soil – vegetation system behind them.

The theoretical penetrating power of "simplifying complexity" is precisely where the scientific value of the soil and water ecological concept lies. It summarizes the complex ecological environ-

ment problems into three major elements and their interrelationships (Fig. 2), enabling people to grasp the essence in the chaotic phenomena and the key in the numerous variables.

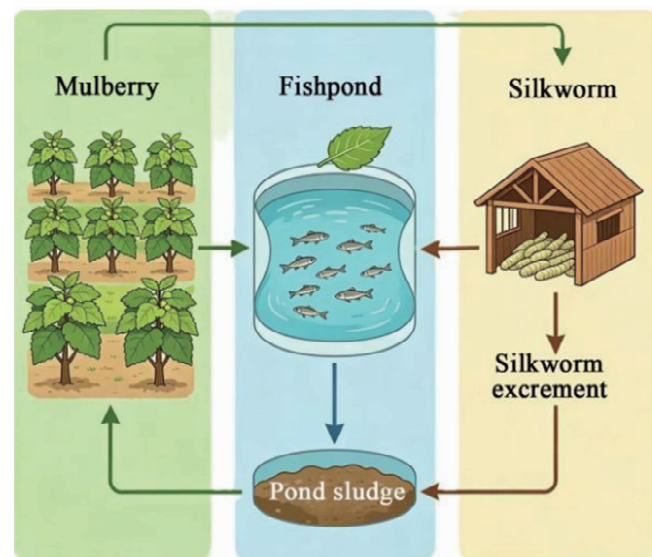


Fig. 1 Circular agriculture model of "mulberry-base fishpond"

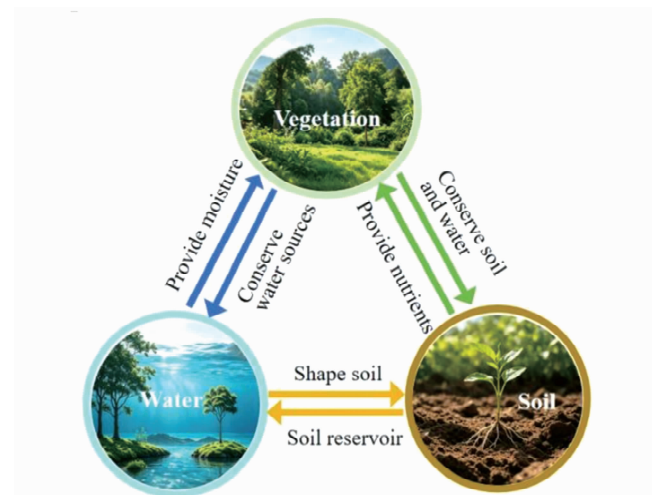


Fig. 2 Coupling relationship among three major elements of water, soil, and vegetation

2.2 Constructing a unified theoretical paradigm Since its inception, ecology has gone through a development process from individual ecology to population ecology, community ecology, ecosystem ecology, and landscape ecology. However, there is a lack of unified theoretical coherence among studies on ecological systems of different scales and types. The concept of soil and water ecology proposes a unified and interconnected path.

2.2.1 Understanding the fundamental dimensions of ecosystems. Any ecosystem, whether it is forests, grasslands, wetlands, farmland, or cities, cannot do without the three major elements of water, soil, and vegetation. Soil and water ecology is the backbone of all ecosystems^[2]. Vegetation is the primary producer of ecosystems, converting solar energy into chemical energy and serving as

the starting point of the food chain; soil is the substrate for vegetation growth and the carrier of nutrient cycling; water is a medium for material migration and an indispensable solvent for life activities. Three essential elements are indispensable, together forming the material foundation and carrier of energy flow in an ecosystem.

2.2.2 Cross-scale ecological research juncture. At the microscale, it studies the transport of water in the soil – plant – atmosphere continuum. At the mesoscale, it studies the soil and water conservation function of small watersheds. On a macro scale, it studies the regional and even global soil and water ecological patterns. The concept of soil and water ecology provides an analytical cognition that runs through different scales, establishing an organic connection between micro mechanisms and macro phenomena.

2.2.3 Foundation of comparative research on ecosystems. Tropical rainforests and cold coniferous forests may seem very different, but from the perspective of soil and water ecology, they are both the result of mutual adaptation among soil, water, and vegetation under specific hydrothermal conditions. Although there are significant differences in structure and function between natural ecosystems and artificial ecosystems, they both follow the basic laws of mutual constraint among water, soil, and vegetation.

2.2.4 Simple yet profound cognitive tool. The charm of the concept of soil and water ecology lies precisely in its simplicity. With the three core elements of "water, soil, and vegetation", the essence of ecological environment problems can be summarized. This simplicity has important cognitive value and operability.

3 Practical significance of the concept of soil and water ecology

The concept of soil and water ecology is a worldview and methodology with profound scientific connotations and extensive practical guidance. It revolves around the three major elements of water, soil, and vegetation, revealing the basic laws of ecosystem operation and providing clear theoretical guidance for human understanding, conforming to, protecting, and using the nature.

The practical significance of the concept of soil and water ecology lies in its ability to guide ecological protection and restoration work, provide theoretical support for ecological civilization construction, and contribute Chinese wisdom to global environmental governance^[6].

3.1 Providing direction and path for ecological protection and restoration

3.1.1 Clarifying the core objects of ecological protection. Protecting the three major elements of water, soil, and vegetation and their interrelationships is fundamental to protecting ecosystems. As long as the bottom line of soil and water ecology is maintained, the basic functions of the ecosystem can be sustained. As long as the balance of soil and water ecology is restored, the ecosystem can move towards a virtuous cycle.

3.1.2 Establishing a comprehensive path for ecological restoration. The concept of soil and water ecology emphasizes that water, soil, and vegetation are an organic whole, and restoration work

must be systematically promoted and comprehensively managed. This means that ecological restoration cannot only pursue a single indicator, but also pay attention to the coordination and coupling degree among water, soil, and vegetation.

3.1.3 Scientific standards for performance evaluation. The concept of soil and water ecology provides a concise evaluation framework: to examine whether water is retained, whether soil is fixed, and whether vegetation is restored and stable. These three indicators are interrelated and easy to monitor, and can serve as the core content for evaluating the effectiveness of ecological restoration.

3.2 Providing theoretical support for the construction of ecological civilization The construction of ecological civilization is fundamental to the sustainable development of the Chinese nation and requires a solid theoretical foundation. The concept of soil and water ecology is highly compatible with the construction of ecological civilization, and can provide important theoretical support for this great practice.

3.2.1 Lucid waters and lush mountains are invaluable assets. Lucid waters and lush mountains are the ideal state for the coordinated development of water, soil, and vegetation, which are interdependent and form the healthy foundation of the ecosystem. Invaluable assets are a diversified transformation of this ecological value, which can be the output of ecological agriculture, the income of ecological tourism, the return of ecological compensation, as well as the income of carbon trading and the added value of ecological products.

3.2.2 Mountains, waters, forests, fields, lakes, grass, sand, ice. The core essence of the concept of a community of life is to emphasize the interconnection and organic unity of various natural elements, and the concept of soil and water ecology is the theoretical expression of this concept. Water, soil, and vegetation are the "skeleton" and "bloodline" of the community of life. Different types of ecosystems such as forests, grasslands, wetlands, and farmland are just specific combinations of water, soil, and vegetation under different conditions, and are different landscape patches. Essentially, they are soil and water ecology^[7].

3.2.3 "Dual carbon" goal. Peak carbon emissions and carbon neutrality are solemn commitments made by China to the international community, and it requires enhancing the carbon sequestration capacity of ecosystems to achieve these goals. The carbon sequestration function of an ecosystem depends on the synergy of water, soil, and vegetation. An ecosystem with suitable water conditions, sufficient soil fertility, and vigorous vegetation growth will inevitably have a higher carbon sequestration capacity.

3.3 Contributing Chinese wisdom to global ecological environment governance The issue of ecological environment is a common challenge faced by all mankind, and the concept of soil and water ecology is precisely such a theoretical contribution with Chinese characteristics.

3.3.1 Reflecting traditional Chinese ecological wisdom. The concept of "unity of heaven and humanity" is the core idea of traditional Chinese philosophy, emphasizing the harmonious coexis-

tence between humans and nature. The concept of soil and water ecology integrates this ancient wisdom with modern knowledge of ecology, hydrology, and soil science, forming a theoretical system that combines cultural heritage and scientific connotation.

3.3.2 Providing simple and applicable analysis tools. The simplicity and universality of the concept of soil and water ecology make it have the potential for cross-cultural and cross-regional dissemination. Whether it is desertification control in Africa, tropical rainforest conservation in Southeast Asia, or watershed management in Latin America, analysis and policies can be implemented from the three dimensions of "water, soil, and vegetation".

3.3.3 Realizing the United Nations' sustainable development goals. The United Nations' 2030 Agenda for Sustainable Development includes 17 goals, including clean water and sanitation (Goal 6), sustainable cities and communities (Goal 11), climate action (Goal 13), underwater life (Goal 14), and terrestrial life (Goal 15), all of which are closely related to soil and water ecology. Using the holistic, symbiotic, and circular wisdom of Eastern soil and water ecology, as well as European and American soil and water management technologies, the healthy development of global ecological governance system can be promoted. The system thinking emphasized by the concept of soil and water ecology can help countries avoid fragmentation tendencies and achieve synergistic effects of multiple goals when promoting the goal of sustainable development.

4 Eight core innovations in the theory of soil and water ecology

The theory of soil and water ecology was originally proposed in 2004, breaking through the limitations of traditional soil and water conservation and classical ecology disciplines, and achieving four levels of original innovation in concept, logic, discipline, and practice.

4.1 Firstly defining the independent scientific category of "soil and water ecology"

4.1.1 Soil and water ecology is not simply the sum of "soil and water + ecology". It extracts the underlying axiom that wherever there is soil and water on Earth, there must be vegetation growth, which in turn protects the ecological resources of soil and water, reflecting the fundamental natural laws applicable globally.

4.1.2 Narrow and broad dual connotations. Narrowly defined soil and water ecology focuses on dynamic balance of water – soil – vegetation; generalized soil and water ecology includes the complete evolutionary balance of surface water, groundwater, atmospheric water; soil, rock-soil, minerals, landforms (surface structure continuum); vegetation, and vegetation dependent animals and microorganisms. Deserts, glaciers, salt lakes, *etc.* belong to extreme soil and water ecological types.

4.1.3 The greatest common divisor of an ecosystem. Soil and water ecology unifies the underlying logic of ecological governance in forests, grasslands, wetlands, watersheds, cities, deserts, and other ecosystems, and is the greatest common divisor of various

ecosystems.

4.2 Unified theory of "three aspects in one" Traditional disciplines view water and soil resources, environmental quality, and ecosystems in a fragmented manner. The theory of soil and water ecology proposes that resources, environment, and ecology are of the same origin and have a three-in-one relationship. It breaks down the barriers between disciplines such as water conservancy, forestry, land use, and environmental protection, and provides a unified cognitive framework across disciplines and departments. Water – soil – vegetation are the material basis for production, and their states determine the regional environmental carrying capacity. The balance of the three maintains the biological cycle and system stability.

4.3 Refactoring the underlying attribution of global ecological issues The theory of soil and water ecology establishes a hierarchical model of ecological contradictions. The first fundamental contradiction is the degradation of soil and water ecology, such as vegetation destruction and soil – water imbalance, which is the overall root cause of all terrestrial ecosystems degradation. The secondary contradiction: anthropogenic environmental pollution. The third contradiction: excessive depletion of soil and water ecological resources.

It clarifies that the ecological and environmental crises such as climate change, land desertification, river shrinkage, and sharp decline of organisms are a derivative problem of the imbalance of water – soil – vegetation, achieving a unified traceability of all ecological problems and solving the problem of fragmented diagnosis of ecological problems.

4.4 Proposing from soil and water conservation 1.0 to soil and water ecological conservation 2.0

4.4.1 Soil and water conservation 1.0. The main goal is to prevent and control soil erosion. Using engineering measures, biological and agricultural technology measures, soil erosion caused by natural or human factors is prevented and controlled, water and soil resources are protected, improved and rationally utilized, and land productivity is maintained and improved^[8–10].

4.4.2 Soil and water ecological conservation 2.0. It synchronizes hydrological regulation, soil improvement, restoration of local vegetation, and prevents and controls land desertification. With the core of rebuilding the health and dynamic balance of water – soil – vegetation, it enhances ecosystem service functions, maintains biodiversity, achieves comprehensive ecological protection and governance of national land space, and improves the economic, ecological, and social benefits of soil and water ecological resources.

By promoting the shift of ecological governance ideas from end of pipe treatment to source system protection and governance, it could provide theoretical basis for the transformation of traditional soil and water conservation, provide theoretical support for the basic national policy of soil and water conservation, promote the construction of ecological civilization, and achieve sustainable development. Differences and connections between soil and water ecology and soil and water conservation are shown as Table 1.

Table 1 Differences and connections between soil and water ecology and soil and water conservation

Dimension		Soil and water ecology	Soil and water conservation
Definition		Studying the ecological balance relationship of water, soil, and vegetation as a whole, the three elements are inseparable organisms	Taking preventive and control measures against soil erosion caused by natural or human factors
Difference	Concept	It is the guiding ideology and the "Dao", emphasizing the whole, system, and harmony. Not only technology, but also economy, concepts, culture, landscape, ethics, philosophy, and so on	It is concrete practice and "technique", emphasizing the governance of problems
	Method	System analysis, comprehensive control, and source protection and governance of the whole area	Engineering, biological, and agricultural technology measures
	Target	Maintaining the health and stability of the entire ecosystem, focusing on state and system, and pursuing long-term ecological balance and sustainable development	Preventing and controlling soil erosion, protecting, improving, and rationally utilizing soil and water resources through engineering, biological, and agricultural measures, maintaining and improving land productivity
Connection		Soil and water ecology is a strategy, while soil and water conservation is a tactic. Soil and water conservation is one of the important means to maintain and restore soil and water ecology. The theory of soil and water ecology promotes the transformation of soil and water conservation from single soil erosion prevention and control to comprehensive protection and restoration of soil and water ecosystems, which is in line with the construction of ecological civilization	

4.5 Constructing a complete evolution gradient of soil and water ecological balance – degradation The evolution law of degradation chain: native soil and water ecological balance → vegetation (land) disturbance → runoff imbalance → soil erosion → soil fertility decline → biological decline → system collapse.

It distinguishes between natural short-term fluctuations and irreversible severe degradation, and establishes grading criteria, providing quantitative theoretical support for grading implementation and effectiveness monitoring of ecological restoration, and filling the theoretical gap in the systematic evolution of degradation gradients.

4.6 Establishing an independent disciplinary system for soil and water ecology There are only sub disciplines such as soil erosion, forest ecology, watershed hydrology and soil and water conservation in the world, lacking a universal underlying theory to govern terrestrial ecology. Soil and water ecology fills this theoretical gap.

A complete disciplinary framework is built based on the cou-

pling relationship among water, soil, and vegetation, an independent foundational theory is formed. It penetrates through the logic within the community of life of mountains, waters, forests, fields, lakes, grasses, and sands, and proposes that the essence of a community of life is the combination of soil and water ecological systems at different scales. As a universal underlying theory in the field of global ecological environment, it is a Nature-based Solutions (NbS) international theoretical sublimation^[11] and has global universal guiding value.

4.7 Reconstructing the logic of harmonious coexistence between humans and nature All human production and construction activities are essentially the transformation of water, soil, and vegetation. The root cause of all ecological contradictions is human disturbance to the balance of water – soil – vegetation^[5]. Establishing the core goal of ecological governance is not about unilaterally transforming nature, but about rebuilding the dynamic balance of water – soil – vegetation. It systematizes the concept of "lucid waters and lush mountains are invaluable assets", establishes a three in one practical thinking of protection, restoration, and sustainable utilization, and connects the theoretical channels of ecological protection and green industry^[12].

4.8 Coordinating new ideas for governance It fills in the gaps in the separation of water conservancy, forestry, agriculture, and natural resources, and proposes a comprehensive and integrated management model for soil and water ecology in the entire region, and a top-level institutional coordination concept^[13], and promotes the transformation of single soil erosion control to the overall management and protection of soil and water ecology in the national territory. It formulates a complete set of practical logic with natural restoration as the main approach and artificial regulation as a supplement, and takes into account the coordinated implementation of engineering measures, biological measures, and hydrological regulation.

5 Conclusions

5.1 Unity of heaven and humanity, humans and nature are a community of life It can be said that humans themselves are the embodiment of water, soil, and vegetation. The value of the concept of soil and water ecology is not only to tell us what we know, but also to help us see connections that we have not seen before. In today's increasingly complex relationship between humans and nature, the ability to perceive deep connections is the key to humanity's journey towards a sustainable future.

5.2 The theory of soil and water ecology is a new discovery of the relationship between humans and nature The complete innovation and breakthrough of fundamental theories are the

conditions that industrial civilization must meet. For example, behind the steam engine is thermodynamic theory, behind the electrical revolution is electromagnetics (Maxwell's equations), and behind the computer revolution is quantum mechanics and Turing's automata theory. These theories are a rediscovery of the laws governing the physical world. There is still a lack of fundamental theoretical breakthroughs in the field of contemporary ecological civilization construction. The theory of soil and water ecology is a rediscovery of the laws governing the relationship between humans and nature, which will drive humanity towards the era of ecological civilization.

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