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Editorial

Two decades of ecological wisdom and scientific progress in China

This year marks the 20th anniversary of the influential concept that “Lucid waters and lush mountains are invaluable assets”, introduced by President Xi Jinping. This theory is central to China's vision of ecological civilization. Over the past two decades, China has made significant advancements in environmental protection and ecological civilization, with eco-enviromental science and technology providing crucial support. To mark China's National Ecology Day, the Chinese Society for Environmental Sciences organized the selection of “Twenty Major Scientific and Technological Achievements in Ecological Civilization Construction.” Chosen by a hundred academicians, these twenty achievements highlight the contribution of China's eco-environmental science and technology innovations to national ecological civilization and global sustainable development (Table 1). This editorial synthesizes these innovative achievements within the context of China's ecological and environmental protection efforts, emphasizing their impacts and future potential.

1. The guiding principles of the “Two Mountains” theory and ecological civilization

Protecting the environment is akin to safeguarding productivity, and improving it drives progress. “Lucid waters and lush mountains are invaluable assets” is a signature and original concept in China's vision for building an ecological civilization. It articulates a comprehensive set of values—harmony between humanity and nature, harmony among people, and harmony between humanity and the economy and society. The concept reflects the distinctive philosophical wisdom, cultural depth, and linguistic richness of the Chinese nation. The “Two Mountains” theory emerged during a period of rapid economic growth in China, which often came at environmental expense, providing a framework to address resource and ecological constraints. It shifted priorities from gross domestic product-focused development to one emphasizing ecological protection and green growth. This approach highlights the interplay between environmental conservation and economic growth, promoting high-quality development where humans and nature coexist harmoniously, with sustainable practices as the norm. It positions ecological protection as a fundamental priority and constraint; in cases of conflict, conservation takes precedence. It emphasizes the enhancement of ecosystem quality and the building of natural assets to create competitive advantages nationally, and improve public well-being, happiness, and security. The theory underscores the economic and social value of healthy environments, illustrating how ecological strengths can translate into development opportunities.

Over the past two decades, guided by this theory, China has achieved substantial progress in ecological civilization and environmental protection. The country has pursued comprehensive reforms of the system for developing an ecological civilization, advancing the Beautiful China Initiative, accelerating green and low-carbon transformation, enhancing equitable access to environmental benefits, and building resource-efficient, eco-friendly economic system. These changes have transformed China's development model and offered practical insights for global challenges in balancing growth with conservation, especially for developing nations. The twenty selected achievements exemplify and support these reforms, demonstrating the scope and depth of China's scientific contributions to ecology.

2. Scientific and technological breakthroughs: foundations of ecological advancement

The twenty achievements encompass diverse innovations supporting China's ecological and environmental protection framework, from basic research to practical applications, reflecting a multifaceted strategy for environmental issues. Together, they show how science is reshaping human–nature interactions in China.

Biodiversity and Ecosystem Health. The compilation of the *Flora of China* (Achievement 1), documenting over 31,000 vascular plant species, offers a comprehensive data resource for biodiversity conservation. This foundational work supports long-term ecosystem stability. Complementing it, research on ecosystem processes and services in the Loess Plateau (Achievement 11) reveals mechanisms for carbon sequestration and water yield in vegetation restoration, guiding ecological protection efforts in vulnerable areas. National Ecological Function Zoning (Achievement 16) provides a framework for tailored protection, identifying 50 key zones essential for national ecological security. These works contribute to the Beautiful China Initiative's goal of harmonious human-nature relations.

Water Resource Management and Pollution Control. The Drinking Water Safety Assurance Technology System (Achievement 2) has enhanced water quality for hundreds of millions through advanced purification and risk management, supporting the widespread access to clean water, which is a key United Nations Sustainable Development Goals (UN SDGs). The Yellow River Water and Sediment Regulation Theory and Practice (Achievement 3) pioneered large-scale regulation, aiding flood control and river health. Offshore wind power technologies (Achievement 5) enhance safety, efficiency, and resilience of wind farm operation in challenging marine environments. Innovations in groundwater pollution control for the Beijing–Tianjin–Hebei region (Achievement 6) and new membrane water treatment technologies (Achievement 7) tackle water pollution, with the latter challenging

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Table 1
Selected achievements.

No.	Title of achievement
1	*Flora of China*
2	Drinking Water Safety Assurance Technology System
3	Yellow River Water and Sediment Regulation Theory and Practice
4	Evaluation and Prevention of Geological Disasters Triggered by the Wenchuan Earthquake
5	Safe and Efficient Offshore Wind Power: Integrated Development Technologies, Equipment, and Industrialization
6	Key Technologies for Groundwater Pollution Control and Application in Beijing–Tianjin–Hebei Region
7	Key Technologies and Applications of New Membrane Water Treatment
8	Mechanisms of Basin Water Cycle Evolution and Efficient Water Resource Utilization
9	Synergistic Deep Treatment Technologies and Applications for Multi-Pollutant Industrial Flue Gas Control
10	Key Technologies for Ultra-Low Emission from Coal-Fired Power Plants
11	Ecosystem Processes and Services in the Loess Plateau
12	Theory and Technology for Air Quality Improvement in Megacities
13	Clean and Efficient Coking: Technology Development, Equipment, and Applications
14	Climate Numerical Modeling, Simulation, and Predictability Studies
15	Key Technologies and Applications for Ecological Water-Saving Irrigation Districts
16	National Ecological Function Zoning
17	Analytical Methods and Formation–Transformation Mechanisms of Typical Persistent Toxic Pollutants
18	Sulfur Dioxide Emission Reduction in China: Theory and Key Technologies
19	Mechanisms of Water–Sediment Disaster Formation and Key Prevention Technologies
20	National Environmental Quality Remote Sensing Monitoring System: Research and Operational Applications

international monopolies in desalination and nuclear wastewater treatment. Basin water cycle research (Achievement 8) provides models and standards for efficient water resource use and ecological protection. These advances support the vision of beautiful rivers and lakes under the Beautiful China Initiative.

Air Quality Improvement and Green Development. Technologies for synergistic treatment of industrial flue gas pollutants (Achievement 9), have substantially cut air pollution emissions from heavy industries. And ultra-low emission technologies for coal-fired power plants (Achievement 10) supported the construction of the world's largest clean coal-fired electricity supply system in China. Clean and efficient coking technologies (Achievement 13) lower pollution generation and energy use in the steel industry. Advanced methods reveal and track formation–transformation of persistent toxic pollutants (Achievement 17), guiding the formulation of control strategies. Theories and technologies for air quality improvement in megacities (Achievement 12), proven during the Beijing Olympics, offer effective solutions and produce the iconic "Olympic Blue". SO_2 reduction theories and key technologies (Achievement 18) have driven substantial emission cuts and acid rain mitigation nationwide. These innovations drive China's shift to sustainable industries and energy system.

Disaster Prevention and Eco-environmental Monitoring. Evaluations and prevention strategies for Wenchuan Earthquake-triggered geological disasters (Achievement 4) provide methods for systematic assessment of earthquake-related geohazards, as well as mitigation approach, such as novel debris flow controls. Research on water-sediment disaster mechanisms and prevention (Achievement 19) strengthen the management capacity of river hazards. The National Environmental Quality Remote Sensing Monitoring System (Achievement 20) integrates satellite, unmanned aerial vehicle, and ground data for real-time environmental oversight, enabling precise governance and rapid responses—a key tool in modern environmental management.

Climate Change and Sustainable Agriculture. Climate numerical models, simulations, and predictability studies (Achievement 14), has been adopted by the Intergovernmental Panel on Climate Change (IPCC), advancing global climate science. Water-saving irrigation technologies (Achievement 15) promote water use efficiency and reduce agricultural pollution, supporting food security and ecosystem health.

3. Future outlook and global contributions

Marking the 20th anniversary of the “Two Mountains” theory, these achievements reflect China's sustained focus on ecological civilization and environmental protection. They form an interconnected foundation for national sustainability strategies, blending science with policy to address issues from pollution control to disaster management.

Moving forward, China's path to a Beautiful China and modernization will rely on ongoing innovation and adherence to core ecological principles. For example, addressing gaps in converting ecological assets to economic gains requires advances in knowledge, mechanisms, and strategies; and expanding integrated environmental monitoring systems (Achievement 20) will support data-driven, proactive, and precise protection.

China's ecological experiences and eco-environmental innovations provide useful models and techniques worldwide, showing that growth and conservation can reinforce each other. The global application of China's advanced technologies, such as the flue gas deep treatment technology (Achievement 9), further highlights China's important role in international environmental efforts. As a proponent of a shared global future, China will continue sharing insights and solutions, collaborating toward a cleaner, greener planet.

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