



ELSEVIER

Contents lists available at ScienceDirect

## Engineering

journal homepage: [www.elsevier.com/locate/eng](http://www.elsevier.com/locate/eng)

## Views &amp; Comments

## A Bright Future for Sustainable Development: Ushered in by Innovation

Jining Chen

Minister, Ministry of Environmental Protection of the People's Republic of China

Sustainable development is defined as “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.” Put simply, sustainable development means that the needs of the present generation should not be satisfied at the expense of the interest of future generations, and developments achieved today should not become a burden or hurdle to tomorrow’s development.

The year of 2015 is a crucial year for sustainable development. Three high-level international conferences of the United Nations (UN) together drew a new roadmap for sustainable development. At the Third International Conference on Financing for Development, held in July in Addis Ababa, 193 UN member states adopted the Addis Ababa Action Agenda, which includes more than 100 specific measures to promote the realization of sustainable development goals. At the end of September the UN Sustainable Development Summit, held at the UN headquarters, adopted the 2030 Agenda for Sustainable Development, which will guide policy and funding for the next 15 years, to replace the Millennium Development Goals. And at the Paris Climate Change Conference in December, member states adopted the Paris Agreement on Climate Change to tackle climate change on the basis of the Intended Nationally Determined Contributions they submitted. All parties committed to work together to hold the increase in the global average temperature at less than 2 °C above preindustrial levels and to limit the temperature increase to 1.5 °C.

In 1992 the UN Conference on Environment and Development, held in Rio de Janeiro, ushered in a new era for sustainable development. As the concept of sustainable development has been increasingly recognized since then, the international community has made great progress in promoting sustainable development and significantly improved the lives of hundreds of millions of people, moving toward achieving Millennium Development Goals.

The *UN Millennium Development Goals Report 2015* shows that the international community has realized goals such as reducing by half the numbers of people in extreme poverty and those without access to improved drinking water sources. The number of people living in extreme poverty decreased from 1.9 billion in 1990 to 836 million in 2015, and the extreme poverty rate (living on less than \$1.25 USD per day) in developing countries dropped

from 47% to 14%. In terms of social progress, primary education enrollment in developing regions reached 91%, and the number of out-of-school children of primary school age declined by nearly 50% compared to that in 2000. The death rate of children under 5 years old decreased by half and that of pregnant women by 45%. Environmental protection improved, as 98% of ozone-depleting substances have been virtually eliminated, and the ozone layer is predicted to recover by the middle of this century. Conservation areas for land and sea in many regions increased substantially, and an additional 1.9 billion people had access to clean drinking water.

As a firm supporter and active player in sustainable development, China has nearly or completely achieved 13 Millennium Development Goals, making great contributions to global sustainable development. From 1990 to 2011, the number of Chinese people living in poverty decreased by 439 million, accounting for 70% of the global decrease. China has fully implemented the 9-year compulsory education policy, and net enrollment rates for both girls and boys of primary school age are above 99%. In addition, China has made great progress in environmental protection. Acid rain pollution has dropped to levels last seen in the 1990s, the quantities of surface water worse than Grade V decreased constantly, the water quality compliance rate of drinking water sources increased steadily, and an additional 500 million people have access to safe drinking water since 2000. Forest coverage rate went up from 16.55% at the beginning of 21st century to 21.63% in 2013, and the ratio of natural conservation area to land area reached 14.84%. Over the past decade, the volume of processed polluted water per day in urban areas rose from 52 million tons to 182 million tons; the ratio of coal-fired power generation units with desulfurization facilities increased from 12% to 99%, and units with denitration facilities from 2% to 92%. The environmental Kuznets Curve witnessed positive changes: Emissions of some pollutants are about to peak and then decline.

But there is still a long way to go to improve environmental quality. China not only focuses on developing itself, but also actively takes part in South-South cooperation, helping more than 120 developing countries to realize the Millennium Development Goals.

Great progress has been achieved in global sustainable development, but a new development model that balances the en-

<http://dx.doi.org/10.1016/J.ENG.2016.01.004>

2095-8099/© 2016 THE AUTHORS. Published by Elsevier LTD on behalf of Chinese Academy of Engineering and Higher Education Press Limited Company. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

vironment and the economy is not sufficiently well established to replace the traditional one of excessive production, excessive consumption, and excessive waste. “Pollution first and cleanup afterward” still prevails in many countries and regions, and we are exploring new modes of industrialization and urbanization. As more people move to urban areas, the need for sustainable development is mounting, and climate change, energy and food security, and regional conflicts pose new challenges to sustainable development.

As for economic and social development, struck by the most serious economic crisis in 2008 since the Great Depression in the 20th century, the world is at a stage of major adjustments. The economic growth of developing countries has slowed down and the salary gap between North and South is still widening. Hundreds of millions of people are living in poverty, suffering from hunger and having no access to basic services. More than 800 million people are living in extreme poverty and 57 million children of primary school age are out of school. In the cities of developing countries, about 880 million people are living in places similar to slums.

Global environmental quality is worsening and the distribution of environmental problems is more unbalanced. Environmental concerns in developed countries and regions are decreasing, but in most of the less developed and developing countries and countries in transition they have not improved—or have even worsened. Notwithstanding progress in dealing with global or regional environmental problems such as ozone layer depletion, most global environmental problems, such as air and water pollution, remain unsolved. Furthermore, new problems—such as pollution from chemical products, mercury, persistent organic pollutants, and cross-border transfer of electric waste—keep emerging.

Climate change is no longer a potential future threat but a real and present fact that must be recognized and addressed now: Since 1990, carbon dioxide emission have increased by over 50%, the global temperature keeps rising, extreme weathers such as hurricanes, droughts, and floods are more frequent, and oceans are acidifying. Nitrogen pollution is a serious global environmental challenge. Nitrogen-containing compounds from the use of fertilizer, burning of fossil fuels, and other human activities are disturbing the Earth’s nitrogen balance, leading to photochemical smog, acid rain, land acidification, ozone layer depletion, and water eutrophication, with adverse effects on agricultural production, biodiversity, climate change, and human health. Water shortage affects 40% of the world’s population; by 2025, this figure will reach two thirds, and the number of people living in countries and regions where water resources are in extreme shortage will reach 1.8 billion.

With these daunting challenges, the traditional development model that exhausted the resources of future generations must be transformed into a more sustainable one. Vigorous efforts have already been made. China now gives higher priority to ecological civilization, and has included it in the “five-in-one” national development strategy. Chinese President Xi Jinping has put forward a range of new concepts, ideals, and strategies on ecological civilization and environmental protection, the most crucial of which calls for upholding green development, recognizing that green mountains and clean water are just as valuable as a mountain of gold and silver.

Achieving ecological civilization requires a shift away from the extensive mode of development and excessive consumption to ensure that human activities do not exceed environmental capacity, a shift toward increasing production, improved livelihood, and a sound eco-environment. In this sense, ecological civilization not only reflects the thinking of sustainable development but also further develops the idea, supporting the belief that environ-

mental protection and economic development go hand in hand and are mutually reinforcing. Efforts to protect the ecosystem can protect nature and increase natural capitals, maintain growth momentum, and promote economic and social development. In short, environmental protection would be the best way to boost development and achieve sustainability.

Moreover, China’s drive toward ecological civilization will have far-reaching global impacts and relevance in fundamentally resolving deep-rooted problems in environment and development. Taking improving environmental quality as our core task, we put in place the most stringent environmental protection system; launched comprehensive campaigns on air, water, and soil pollution prevention and control; enhanced supervision over law enforcement, while also accelerating and deepening reforms; and provided more quality ecoproducts by promoting a green way of life and production. These measures will yield a beautiful China with blue sky, fresh air, and clean soil.

Meanwhile, we are also keenly aware of the significance of innovation in pursuit of sustainable development, especially in two dimensions.

First is innovative thinking. The mind guides the individual’s actions, and actions shape the future. The key is to give equal emphasis to both knowledge and actions, and to make actions speak louder than words. But it is usually more difficult to take actions than to learn, and it is no different with sustainable development. We need to foster a favorable environment to mobilize society and encourage everyone to take actions voluntarily and consciously. Sustainable development will require a sustainable way of thinking about production, consumption, development, and management to help people consciously change their behaviors. If everyone adopts the extravagant lifestyle and excessive consumption of some Western countries, even if other planets are made habitable, it will not be possible to meet the tremendous demands.

To take action, we first need a fundamental change in people’s values and behaviors. We call for the entire society to resist irrational, excessive consumption—such as high energy use—as well as high expenditures and huge waste. At the same time, we also need to promote green consumption, which will require transformation of the traditional production model and boost social and economic development with fewer resources.

The second area of innovation in support of sustainable development is technology. Technological innovation is an important path toward a sustainable future, it has been an inexhaustible engine for the rapid development of productivity since the Industrial Revolution, and will also provide the basis for sustainable development. The so-called “limits to growth” or the “global catastrophe” predicted by the Club of Rome never happened. Scientific and technological progress can offset the negative effects of population growth and increasing energy and resource consumption.

As a result of research and innovation, the world today witnesses increasingly rapid development in new technologies, products, materials, and findings. There is a growing integration of information technology, biotechnology, and technologies related to new energy and materials, triggering a new round of technological and industrial revolution. Ultimately, such advances will enable people to shift away from the traditional model of production and high resource consumption at the expense of the environment.

Resources and the environment are key areas for innovation. An emerging concept, ecological innovation, is drawing widespread attention from the international community. To a large extent, it is based on the practice of individuals as well as small and medium-sized enterprises, and thus is an area for bottom-up

innovation. Drawing reference from nature, where all kinds of substances are interconnected through the exchange of nutrition and energy, ecological innovation highlights the physical law and the natural law, and takes them as the basic principles in choosing raw materials and ways of production. In this sense, resource consumption will primarily depend on physical properties rather than the use of chemical irritants, effectively minimizing resource consumption.

A variety of technologies related to pollution management, bio-remediation, and ecological restoration enjoy broad prospects. Once they are ready to be applied and commercialized, substantial progress will be seen in environmental management, resource reuse and recycling, and environmental remediation.

For example, China is vigorously promoting ultra-low-emission retrofitting for coal-fired power plants. Such retrofitting is achieved mainly through multi-pollutant control technology, which reduces emissions of major air pollutants from coal firing units to the level of those from natural gas boilers and gas turbine units. Ultra-low emission retrofitting now applies to 160 million kilowatts of energy production. Since 2005, despite an increase of 460 million kilowatts (118%) in installed capacity of coal-fired power plants and a 90% increase of thermal coal, sulfur dioxide emission in China's power sector was reduced by 48% and nitrogen oxide by 26%.

In addition, the international community is working on the application of source separation technology for municipal wastewater treatment. Specifically, instead of being mixed with other municipal wastewater, sewage is collected, transported, and treated separately for use as fertilizer. This approach has multiple benefits. First, it can reduce the use of toilet-flushing water by 90%. Second, it reduces nitrogen, phosphorus, and other water pollutants while retaining and utilizing the nutritious substance. Third, it can relieve the burden of transmission and treatment of urban drainage systems, and make them even more cost-effective in reusing reclaimed water.

Similar technological innovations are found everywhere, impacting and changing our life and way of production all the time. Emerging ecological innovations can help address the huge challenges facing this era, and open the window of opportunity for new products and services.

Sustainable development presents both challenges and opportunities, especially the opportunity for scientific and technological innovation. Focusing on sustainable development, China is working to promote multidisciplinary innovations in science and technology, industry, marketing, production, business, and management to transform the popular way of life and standard models of production, and to contribute to a sustainable world and a better homeland.