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Current Situation and Tasks of Ecological Civilization Construction in China

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Abstract: To establish development goals and identify development priorities, deepening the strategic layout for ecological civilization construction in China requires an international comparison thereof in China and abroad. This research establishes an indices system for the international comparison of ecological civilizations; evaluates the Group of Twenty (G20) economic entities based on their ecological condition, environment quality, social development, and resources utilization; and ranks the G20 economic entities on the ecological civilization index 2017 and the ecological civilization progress index (1990–2015). The results show that China's level of ecological civilization construction is far behind that of most countries, especially in terms of environmental quality and resource utilization. However, the speed of China's construction ranks first among the G20 economic entities. This research analyzed the task hierarchies, strategic emphases, and time nodes required for China to catch up with an advanced level of ecological civilization construction.

Keywords: ecological civilization construction; international comparison; ecological condition; environmental quality; social development; resources utilization

1 Introduction

Construction of an ecological civilization (hereafter eco-civilization) is at the forefront of green development for a brighter future. Since the 20th century, traditional industrial civilization has upset the balance between humans and nature, resulting in severe ecological damage, environmental pollution, and resource shortages. In view of the worldwide trend for green development, several environmental ideas and practices have successively emerged, such as the environmental protection movement, sustainable development, and ecological modernization. Based on this, China proposed the concept of eco-civilization construction and put into practice the realization of a harmonious win-win situation between humans and nature. Here, the following question arises: What image is China presenting to the international community concerning the level and speed of its eco-civilization construction? The research group conducted a comprehensive quantitative evaluation of the level of eco-civilization construction in China; in representative developed economies such as the United States, Britain, France, and the EU; and in emerging countries including India, Russia, South Africa, and Brazil. The evaluation aimed to clarify the international level of China's eco-civilization construction, discover its achievements and shortcomings, highlight key tasks, and advance construction. The evaluation of the speed of construction used 2015 as the assessment year and 1990 as the contrast year.

2 Connotation and evaluation of eco-civilization construction

The core of eco-civilization is mutual harmony between humans and nature, which emphasizes "civilization" and "ecology." Civilization is the total of all progress made by man in every sphere through the representation of humans' basic living style,

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and indicates the level of social progress. Eco-civilization sets two basic standards for the progress of human society. One is the value scale for promoting the free and comprehensive development of humans, and the other is the ecology scale for maintaining the lasting sustainability of resources and the environment. Traditional industrial civilization has loopholes in the two scales, because it rests on the logic of the unlimited expansion of capital, in which all values including humans are simplified as economic value and defined by one-sided pricing. However, traditional industrial civilization posits humans as a natural ruler and positions their essential power in an improper binary antagonistic relationship. Therefore, it contributes to the mass plunder of natural resources and serious damage to the environment, ultimately leading to an ecological crisis.

Eco-civilization assimilates the essence and discards the dross of traditional industrial civilization. Furthermore, it requires a reexamination of the relationship between human society and the ecosystem. The ecosystem is a "system," the foundation of human society that provides two basic uses for humans: the environment and resources. Centered on humans, the environment refers to the collection of basic elements meeting biological characteristics of human needs within the ecosystem. Resources are defined as elements that can be utilized by humans via technologies and indicate the practical characteristics of mankind. Thus, the ecosystem is a system, while the environment and resources are the uses thereof. This is referred to as the theory of "one system in itself and two uses for people" [1–3]. The reason for the ecological crisis is the unreasonable and excessive exploitation of resources that bring about environmental pollution. Environmental pollution means that the connection of an ecosystem is cut off or its utilities are irrationally damaged by humans. Thus, the ecosystem has difficulty in handling pressure and defending against collapse [4].

In terms of understanding the theory of "one system in itself and two uses for people" between human society and the ecosystem, eco-civilization construction should concentrate on strengthening the system and optimizing its uses. Correspondingly, a quantitative evaluation could focus on four dimensions: whether the ecosystem has vitality, whether the quality of the environment is good, whether the social undertaking is highly developed, and whether resource utilization is efficient. From the perspective of utility, both the improvement of environmental quality and sustainability of resource utilization are contingent on the balance and stability of the ecosystem. From the perspective of the ecosystem, the restoration and construction thereof increases environmental capacity and provides an abundant reserve of resources. In addition, the developed social undertakings are an indispensable symbol of eco-civilization, complying with the practical desire of people to pursue happy lives and the basic law of social development.

This evaluation was an international comparison of eco-civilization construction based on the principles of orientation, authority, and availability. By using a multi-index comprehensive evaluation method, the research group used ecological condition, environmental quality, social development, and resource utilization as the analysis variables, and constructed a three-layer evaluation index framework—"overall index, analysis variables, and specific index" (Table 1)—for the level (based on cross-sectional data) and speed (based on time series data) of eco-civilization construction. The weight score in the index system was calculated through the Delphi method and assigned after consultation with experts. The weight value was calculated in line with the proportion of the tertiary index for the whole[†]. Adopting a relative evaluation method, the quantitative evaluation used the *Z*-score (standard score) to transform the raw data of the tertiary index into a *Z*-score. After that, the *Z*-scores of primary and sec-

Table 1. Eco-civilization construction international comparison index.

Primary index	Secondary index	Tertiary index	Weight score	Weight value	Index attribute
Eco-civilization index	Ecological condition (25%)	Forest cover rate (%)	6	15.00	Positive indicator
		Natural reserves of total territorial area (%)	4	10.00	Positive indicator
	Environmental quality (25%)	PM 2.5 annual average concentration ($\mu g \cdot m^{-3}$)	3	8.33	Negative indicators
		PM10 annual average concentration ($\mu g \cdot m^{-3}$)	2	5.56	Negative indicators
		Chemical fertilizer application intensity ($kg \cdot hm^{-2}$)	4	11.11	Negative indicators
	Social development (20%)	GDP per capita (constant dollar value in 2010)	5	12.50	Positive indicator
		Average life expectancy (age in years)	3	7.50	Positive indicator
	Resource utilization (30%)	Energy utilization efficiency (purchasing power parity of dollar's GDP per kilogram of oil equivalent)	5	11.54	Positive indicator
		Water utilization efficiency (GDP of constant dollar value in 2005 per cubic meter)	4	9.23	Positive indicator
		CO2 emissions per GDP (kilogram per GDP of constant dollar value in 2010)	4	9.23	Negative indicators

[†] The value of the weight score indicates the degree of importance of each index in the system. The total weight value of the index system is 100. The weight value of each secondary index is calculated from the sum of the weight values of the tertiary indices.

ondary indexes were calculated for the weighted sum according to the weight of the index. Finally, the *Z*-score was converted to the *T*-score ($T=10\times Z+50$) to produce the eco-civilization index. The procedure to calculate the eco-civilization progress rate comprised three steps. The first step involved calculating the progress rate of each tertiary index, which is the comparison between the benchmark and latest year. Second, the progress rate of the secondary index was calculated according to the index weight. In the third step, the primary index was calculated, which is also the weighted sum of secondary indices.

3 Current situation of eco-civilization construction in China

Using the eco-civilization construction international comparison index and referring to the statistics released by the World Bank, the research group investigated the eco-civilization level and development status of the Group of Twenty (G20) economic entities to obtain the eco-civilization index 2017 and eco-civilization progress index (1990–2015). The report revealed that the overall eco-civilization level of China ranks poorly among the G20 economic entities, and there is much room for improvement. Furthermore, the report shows that China has made great efforts and progress in eco-civilization construction since 1990. As a result, China ranks first among the G20 economic entities on the eco-civilization progress index, far in advance of other economic entities.

3.1 China's eco-civilization construction has a big promotion space compared with developed countries'

Regarding the level of eco-civilization construction, China is at a disadvantage among the G20 economic entities. China's score on the eco-civilization index 2017 is 41.47, only a little higher than that of India (41.16) (Fig. 1). As such, China's construction development in major fields is imbalanced. The ecological condition of China is at the middle level, ranking 13th, the closest to the average G20 level. Regarding social development, China is ranked 16th at a middle-lower level, complying with the country's economic development, and is closer to the G20 average. However, the performance of environmental quality and degree of coordination are the worst, ranking at the last and second last positions, respectively, with a gap in the average G20 level (Table 2).

The outcome of eco-civilization construction in China is remarkable, and the country's score is similar to that of Britain (46.49). The two countries have their own merits in forest ecosystem maintenance and biodiversity protection. In 2015, the forest coverage of China (22.19%) was higher than that of Britain (13.00%). In 2012, the proportion of natural reserves in Britain's land area totaled 23.37%, exceeding that of China (16.12%). However, there is a large gap between the two countries and Japan and Germany. The former (68.46%) is ranked first among the G20 economic entities for forest coverage, and the latter (49.04%) first on the natural reserve scale. Generally, China's ecological construction could still improve.

Environmental quality problems in China have aroused worldwide attention in recent years. The score for China's environmental quality construction is the lowest among the G20 economic entities. Air quality has been the pain point of China's environmental improvement for several years. China's average annual concentration of $PM_{2.5}$ and PM_{10} ranks last and third last, respectively, which is not optimistic. Regarding the soil envi-

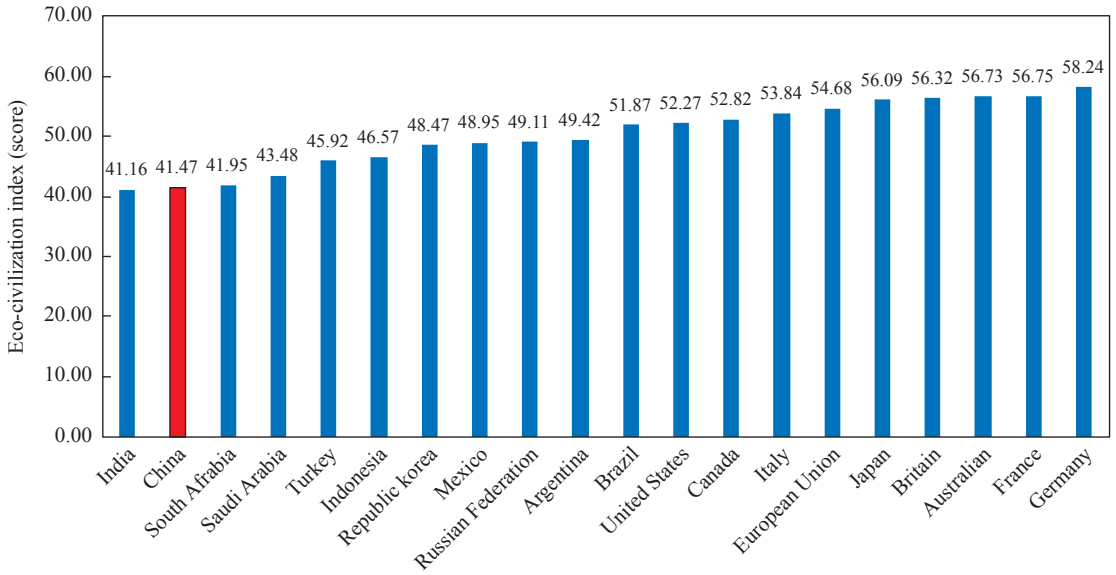

Fig. 1. Eco-civilization index 2017 of G20 economic entities.

Table 2. Eco-civilization construction score comparison between China and G20 economic entities for 2017.

	Eco-civilization index	Ecological condition index	Environmental quality index	Social development index	Resource utilization index
China	41.47	46.85	38.50	42.80	38.58
G20 minimum	41.16 (India)	38.93 (South Africa)	38.50 (China)	32.66 (South Africa)	38.07 (Russia)
G20 maximum	58.24 (Germany)	61.88 (Brazil)	71.72 (Australia)	63.04 (Australia)	67.96 (England)
G20 average	50.31	50.00	50.67	50.00	50.46

ronment, the application intensity of chemical fertilizer in China totaled 364.38 kg·hm^{-2} [5] in 2013, the highest among the G20 economic entities. This implies that severe soil pollution exists in China, and the priority is to change the extensive pattern of agricultural production and operation.

In terms of social development, China scores higher than Russia, Indonesia, India, and South Africa, but still needs to race to the top. Furthermore, China's per capita GDP is not high. In 2015, its per capita GDP was 6416.18 USD (calculated in constant dollar value in 2010 with inflation factors deducted), merely 14.61% of that of the Group of Seven (G7), below the average of the BRIC countries (7894.72 USD), and only higher than Indonesia and India. Regarding average life expectancy, a comprehensive indicator reflecting social life, China's average in 2014 was 75.78, 13th in the G20 economic entities, at the middle and lower level. Even though the average life expectancy is higher than that of Turkey, Brazil, Saudi Arabia, Russia, Indonesia, India, South Africa, and other countries, it is still much lower than that of the developed countries, where the average life expectancy is over 80 years.

In addition, China faces the urgent task of improving the efficiency of resource utilization. China's overall score in this field is only higher than that of Russia, with energy, water utilization efficiency, and carbon dioxide emissions per unit of GDP ranking low. In 2013, every kilogram of oil equivalent consumed in China brought about a GDP output of 5.48 USD. Energy consumption is 52.73% of the average of the G7 countries, and 75.58% of that of the BRIC countries. In 2014, China's freshwater utilization efficiency was 9.51 USD GDP per cubic meter, 3.85% of that of Britain in the same year. In 2011, China's carbon dioxide intensity was 1.36 kg per purchasing power parity of dollar's GDP (constant dollar value in 2010), 6.12 times the average of the G7 countries and 1.47 times the average level of the BRIC countries. Considering China's increasing economic aggregate, its resource utilization efficiency must be improved urgently.

3.2 Since the 1990s, China has rapidly advanced in eco-civilization construction and development

Although the level of construction is not satisfactory, China has certainly progressed in all aspects of eco-civilization construction. From 1990 to 2015, China's progress index for the overall level of eco-civilization was 210.28% (Fig. 2), of which the progress index for social development construction was 493.54%, for resource utilities 354.32%, for ecological condition construction 28.97%, and for environmental quality −7.87% (Table 3). The progress of several tertiary indexes for China, such as forest coverage rate, per capita GDP, energy utilization efficiency, water utilization efficiency, and reduction in carbon dioxide emissions per unit of GDP ranks first among the G20 economic entities.

For more than 20 years, China has contributed to global ecological security. From 1990 to 2015, China's overall growth rate of forest coverage ranked first among the G20 economic entities, with a progress rate of 32.57%. The average annual growth rate was 1.13%, 3.77 times the average rate (0.30%) of the G7 countries. The global forest area has been decreasing for many years, declining from 31.74% (4.128×10^9 hm^2) in 1990 to 31.13% (3.999×10^9 hm^2) in 2015. From 2010 to 2015, China exhibited the largest net increase in forest area, with an average annual increase of 1.542×10^6 hm^2 [5,6].

In China's eco-civilization construction, environmental quality is the only core construction area with significant retrogress; however, there are also a few bright areas. Regarding the control of the average annual concentration of air pollutant PM_{10}, China's progress was 48.34% between 1990 and 2011, a significant decline. However, with the complexity of China's air pollution, the concentrations of new air pollutants represented by $PM_{2.5}$ have continuously increased. Therefore, there is still a long way to overall improvement. In addition, soil pollution is deteriorating, as the intensity of the application of chemical fertilizer and pesticides has increased beyond the reasonable limit in many areas, leading to water pollution.

Since reform and opening up, China's economic construction has developed rapidly, promoting social progress, improving comprehensive national strength, and raising the people's living standard. These aspects provide a solid basis for eco-civilization construction. In 1990, China's per capita GDP was 725.98 USD (constant dollar value in 2010), increasing to 6416.18 USD by 2015, with a total growth rate of 783.8% and average annual growth rate of 9.11%. The average annual growth rate of the G7 countries is 1.09% and 1.87% for other BRIC countries.

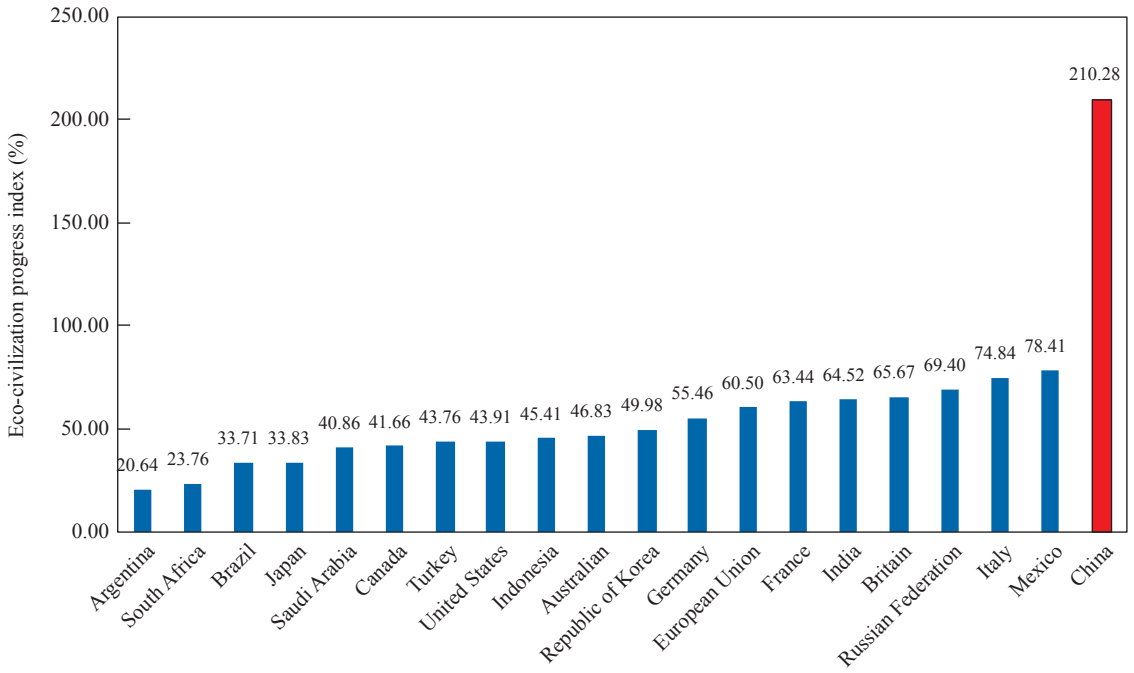

Fig. 2. Eco-civilization progress indexes of the G20 economic entities (1990–2015).

Table 3. Comparison of eco-civilization construction speed between China and the G20 economic entities (1990–2015). (%)

	Eco-civilization progress index 2017	Ecological condition progress index	Environmental quality progress index	Social development progress index	Resource utilization progress index
China	210.28	28.97	−7.87	493.54	354.32
G20 Maximum	210.28 (China)	192.81 (Mexico)	55.13 (France)	493.54 (China)	354.32 (China)
G20 Minimum	20.64 (Argentina)	2.06 (South Africa)	−22.91 (India)	8.59 (Italy)	16.89 (Brazil)
G20 Average	58.34	50.32	18.41	64.30	94.33

China's economic miracle also contributes to its eco-civilization construction.

In terms of improving the speed of resource efficiency, China is rapidly transforming positively from the extensive development pattern in the past. From 1990 to 2013, the progress rate of China's resource utilization efficiency was 328.76%, with an average annual progress rate of 6.53%, 1.77 times that of the G7 and 1.82 times that of other BRIC countries. Regarding freshwater utilization efficiency, China's progress rate was 621.69% between 1992 and 2014, with an average annual progress rate of 9.40%, 3.85 times that of the G7 and 3.23 times that of other BRIC countries. Moreover, China plays a leading role in reducing carbon dioxide emissions per unit of GDP.

4 China's eco-civilization construction tasks

The international compassion report delineates China's eco-civilization construction tasks into two levels. The first is self-transcendence and the second is that we should try to attain an advanced level, gradually achieving all-round and high-level eco-civilization construction. We must make use of the speed advantage of construction to change the temporary backward condition of overall construction.

4.1 Two levels of construction tasks

To achieve eco-civilization, China faces the challenges of self-transcendence emerge from two aspects. First, the backward condition of environmental quality is difficult to change in a short time. Second, pollutant emissions have become a bottleneck in improving the overall level. These challenges have commonalities with late-development countries, and are subject to the deteriorating global ecological crisis. Taking the change of average annual concentration of $PM_{2.5}$ as an example, the concentrations of China, India, Brazil, and North Africa tend to increase continuously. However, in developed countries including Britain, Germany, France, and America, they have rapidly decreased by more than 50% from 1990 to 2013. Therefore, a

sharp contradiction is evident for environmental protection in fast-developing and emerging countries. Furthermore, because of population growth, food shortages, climate change, and other factors, most countries including China have improved the application of pesticides and chemical fertilizers to strengthen food security, at a higher cost to the environment.

Predictions for the development tendency based on present construction speed highlight that, with the deepening of eco-civilization construction, China will gradually catch up with developed countries in related construction fields. In terms of per capita GDP and average life expectancy, China needs at least 10 to 20 years to surpass the United States. Furthermore, regarding energy and water utilization efficiency, it needs 15 to 20 years to catch up with the United States and Japan. For carbon dioxide emissions per unit GDP, almost 20 to 40 years are needed for China to catch up with Japan and the United States. Compared with G20 economic entities with the highest construction level according to tertiary indicators, China will need more time to catch up.

By 2030, China's eco-civilization construction will likely present the following situation. Ecological construction will steadily develop, although the speed will need to increase. There will be some improvement in environmental quality, while challenges will still exist regarding air pollution and soil contamination. Social development will achieve remarkable results and social warfare will have improved. Resource utilization efficiency will have improved, although the intensity and total of pollutant discharge or emissions will not both have decreased. As a result, the contradiction between development and protection will not be substantially alleviated. China's current development level in specific construction areas is the same as that of high-income countries 20 to 40 years ago. The difficulty in fulfilling the tasks in four construction areas increases in turn from resource utilization to social development, to ecological vitality, and finally to environmental quality.

4.2 Key advancements in future eco-civilization construction

How can China's eco-civilization level be advanced to make it conform to the country's power status and achieve social and economic development? In the context of continuously improved social development, according to the characteristics and shortcomings noted in the international comparison report, China can advance its eco-civilization construction through the following four aspects.

First, China should position ecology at its base, consolidating and enhancing the foundation of its eco-civilization construction. We should consolidate ecosystem vitality in terms of quantity and quality. While steadily improving the forest coverage rate, we must enhance the quality of forest resources and increase the ecological service capacity of these forests. Furthermore, we should protect wetlands and grasslands, and curb the developing trend of land rocky desertification. We should also strengthen the construction and management of terrestrial and marine nature reserves, protect biodiversity, and maintain the prosperity of all types of ecosystems.

Second, we should continue to implement various initiatives to curb the deterioration of environmental quality, and reduce the intensity and amount of pollutant discharge or emission. We must actively push the transformation of production modes and rapidly popularize a green lifestyle. As such, we should push for production advancement on one hand and life improvement on the other. Through the transformation of production modes such as the development of green agriculture, we can reduce soil and groundwater pollution caused by the excessive use of chemical fertilizers and pesticides. At the same time, we should reduce the emission of pollutants, reversing the increasing trend of the major pollutants of water, soil, and the air in the process of urban planning and construction as well as the transformation of production mode and lifestyle.

Third, China should continue to strive for greater improvement in the efficiency of conventional resources including water and energy, and extend the lifecycle of resources. Because of a shortage of fresh water, China must make greater efforts to protect it, and enhance the circulating utilization of water resources. Moreover, China must optimize its energy structure, promote the use of high-quality clean energy and alternative energy, and provide support and policy supervision regarding techniques to improve energy utilization efficiency.

In addition, China should learn from the advanced experience of other countries of eco-civilization construction and explore a development mode with Chinese characteristics based on its own reality. Only in this way can China grasp new opportunities to make history and enter the new era of eco-civilization.

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