Supplementary Materials S1

Table S1. Three-level indicator composition for Cultural Heritage (B1).

Goal	Frist-level Indicators	Second-level Indicators		Third-level Indicators		Data Sources
Cultural Sustainability（A）	**Cultural Heritage（B1）**	Scale and value of tangible cultural heritage（C11）	D11-1	Number of items on the World Heritage List in the region (number): including the number of items on the World Cultural Heritage List, the World Cultural and Natural Dual Heritage List, the World Heritage of Cultural Landscapes, and the World Natural Heritage List in the region (number)	+	I II III
			D11-2	Number of national grade A and above scenic spots in the region (number)	+	
			D11-3	Number of national vital villages and towns for rural tourism in the region (number): including the number of national key villages and towns for rural tourism in the region (number)	+	
			D11-4	Number of national-level red tourism classic scenic spot bases in the region (number)	+	

	D11-5	Number of national-level cultural and ecological protection zones in the region (number)	+	
	D11-6	Number of five-star hotels in the region (number)	+	
	D11-7	Number of representative items of tangible cultural heritage in the region that can be verified for the most prolonged period (number)	+	
	D11-8	Number of representative items of tangible cultural heritage in the region for which cultural and creative products have been developed (number): including the number of representative items of world cultural heritage, representative items of dual cultural and natural heritage, representative items of world cultural landscape heritage and representative items of world natural heritage in the region for which cultural and creative products have been developed (number)	+	II

Scale and value of intangible cultural heritage（C12）	D12-1	Number of items selected for the national or above intangible cultural heritage list in the region (number)	+
	D12-2	Number of national-level demonstration bases for productive protection of intangible cultural heritage selected in the region (number)	+
	D12-3	Number of representative bearers of national-level representative items of intangible cultural heritage selected in the region (number)	+
	D12-4	Number of representative items of intangible cultural heritage in the region that can be verified for the longest time (number)	+

			D12-5	Number of representative items of intangible cultural heritage in the region for which cultural and creative products have been developed (number)	+	II X

Table S2. Three-level indicator composition for Cultural Vitality (B2).

Goal	Frist-level Indicators	Second-level Indicators	Third-level Indicators			Data Sources
Cultural Sustainability	**Cultural Vitality（B2）**	Cultural Presence（C21）	D21-1	Number of arts institutions in the region (number): including the number of performing arts organizations, performing arts venues, arts education institutions, arts and cultural research institutions, and creative institutions for arts exhibitions (number)	+	I IV
			D21-2	Number of libraries in the region (number)	+	
			D21-3	Number of group art centers and cultural centers (stations) in the region (nos.)	+	
			D21-4	Number of cultural relics institutions in the region (number): including the total number of museums, cultural relics protection management institutions, cultural relics research institutions, cultural relics stores and other cultural relics institutions (number)	+	
			D21-5	Number of culture and related industry enterprises on a large scale in the region (number)	+	

D21-6	Number of press and publishing organizations in the region (number)	+
D21-7	Number of radio programs in the region (sets)	+
D21-8	Number of TV programs in the region (sets)	+
D21-9	Total number of cable and digital TV subscribers (10,000 households): including total cable TV subscribers and digital TV subscribers (10,000 households)	+
D21-10	Total length of cable radio and TV transmission network trunk lines (kilometers)	+
D21-11	Fixed Internet broadband access users in the region (10,000)	+
D21-12	Number of social media using the Internet for cultural and creative production, marketing and dissemination in the region (nos.)	+

D21-13	Number of movie projection organizations in the region (number)	+
D21-14	Number of movie screenings in the region (10,000)	+
D21-15	Number of movie screening audiences in the region (10,000)	+
D21-16	Revenue from movie screening in the region (billion yuan)	+
D21-17	Number of cultural and entertainment institutions in the region (number)	+
D21-18	Number of general higher education institutions in the region (number)	+
D21-19	Number of graduates of general institutions of higher education in the region (persons)	+

D21-20	Number of students enrolled in general institutions of higher education in the region (persons)	+
D21-21	Number of students enrolled in general institutions of higher education in the region (persons)	+
D21-22	Number of Teaching Staff in General Colleges and Universities in the Region (persons)	+
D21-23	Number of foreign students in the region (persons)	+
D21-24	Number of vocational artists in the region (persons)	+
D21-25	Share of the number of employees in the culture, sports and entertainment industry at the end of the year in the region in the total number of employees at the end of the year in the region (%)	+
D21-26	Year-end number of employees in the education sector in the region as a share of the total number of employees in the region at the end of the year (%)	+

	D21-27	Share of the number of employees in the scientific research and technology service industry at the end of the year in the total number of employees in the region at the end of the year (%)	+
	D22-1	GDP growth rate of culture, sports and entertainment industry in the region (%)	+
	D22-2	GDP growth rate of education industry in the region (%)	+
	D22-3	GDP growth rate of scientific research and technology services industry in the region (%)	+
Cultural Participation（C22）	D22-4	Share of GDP of culture, sports and recreation industry in the region in the total GDP of the region (%)	+
	D22-5	GDP share of education sector in the region to total GDP in the region (%)	+
	D22-6	GDP share of scientific research and technical services industry in the region in total GDP in the region (%)	+

Cultural Support（C23）	D22-7	Share of per capita consumption expenditure on education, culture and entertainment in the region in the total consumption expenditure of residents in the region in the year (%)	+	
	D22-8	Growth rate of per capita consumption expenditure on education, culture and recreation of residents in the region by year (%)	+	
	D22-9	Culture search index in the region	-	IX
	D22-10	Number of regulations and normative documents in force in the region that address the culture and tourism bureau system (articles)	+	VIII
	D22-11	Total number of social organizations, foundations and private non-enterprise units established in the region to support or protect the development of culture and art (number)	+	IV
	D22-12	Number of volunteer projects serving culture and arts in the region in the year (number)	+	IV XI
	D22-13	Total number of volunteer teams registered to serve culture and the arts in the region in the year (number)	+	

D22-14	Number of institutions such as ruling cultural departments and arts councils established by the government in the region (number)	+	VIII
D22-15	Share of general public budget expenditure on culture, tourism, sports and media in the region (%)	+	
D22-16	Growth rate of general public budget expenditure on culture, tourism, sports and media in the region (%)	+	I IV
D22-17	Share of expenditure on culture, tourism, sports and media in the general public budget (%)	+	
D22-18	Number of news reports and announcements on overseas exchange visits by artists and organizations in the region (articles)	+	
D22-19	Number of News Reports and Announcements on Visits of Foreign Artists and Organizations (Articles)	+	VIII
D22-20	Number of Friendship Relations between Governments and Foreign Cities in the Region (nos.)	+	

Table S3. Three-level indicator composition for Economic Vitality (B3).

Goal	Frist-level Indicators	Second-level Indicators	Third-level Indicators			Data Sources
Cultural Sustainability	**Economic Vitality（B3）**	Internal Cycle Economic Vitality（C31）	D31-1	Yearly GDP in the region (billions of yuan)	+	I VI
			D31-2	GDP per capita for the year in the region (million yuan)	+	
			D31-3	GDP growth rate in the region (%)	+	
			D31-4	Share of tertiary industry in the region by year (%)	+	
			D31-5	Share of tertiary industry GDP growth in the region by year (%)	+	
			D31-6	Share of tertiary industry GDP in total GDP growth in the region in the year (%)	+	
			D31-7	Labor productivity of all employees in the region (yuan/person)	+	
			D31-8	Growth rate of total labor productivity in the region (%)	+	
			D31-9	Intensity of Research and Experimental Development (R&D) Expenditure (RMB billion)	+	
			D31-10	Growth rate of financial expenditure on science and technology in the region (%)	+	
			D31-11	Number of invention patent authorizations per 10,000 population (pieces)	+	
			D31-12	Growth rate of invention patent authorization per 10,000 population (%)	+	
			D31-13	Number of high-tech enterprises per 10,000 population (number)	+	
			D31-14	Growth rate of annual general fiscal budget revenue in the region (%)	+	
			D31-15	Share of total retail sales of consumer goods in GDP by year in the region (%)	+	
			D31-16	Growth rate of total retail sales of consumer goods in the region in the year (%)	+	
			D31-1	Share of total export value in the region by year (%)	+	

			D31-2	Growth rate of total export value in the region (%)	+	
			D31-3	Share of growth in foreign direct investment (FDI) in real terms in the region (%)	+	
			D31-4	Share of foreign direct investment in the tertiary sector in the region (%)	+	
			D31-5	Number of travel agencies operating outbound tourism in the region (number)	+	
		External Cycle Economic Vitality（C32）	D31-6	Number of Domestic Tourists Visiting the Region in a Year (10,000)	+	
			D31-7	Number of international tourist arrivals in the region (million)	+	
			D31-8	International Tourism (Foreign Exchange) Income in the Region by Year (USD billion)	+	
			D31-9	Growth rate of international tourism (foreign exchange) income in the region (%)	+	

Table S4. Three-level indicator composition for Cultural Diversity (B4).

Goal	Frist-level Indicators	Second-level Indicators	Third-level Indicators			Data Sources
Cultural Sustainability	**Cultural Diversity（B4）**	Diversity of Population（C41）	D41-1	Number of permanent residents in the region (10,000)	+	I V
			D41-2	Percentage of permanent resident population in the region (%)	+	
			D41-3	Number of foreign permanent residents in the region as a proportion of the permanent population (%)	+	
			D41-4	Number of Hong Kong, Macao and Taiwan residents and foreigners in the region as a proportion of the total population (%)	+	
			D41-5	Number of Han Chinese in the region as a proportion of the total population (%)	+	
			D41-6	Ethnic Minority Population in the Region (%)	+	

		D42-1	Share of population with primary and secondary school education or below per 100,000 population in the region (%)	-	
	Diversity of Education（C42）	D42-2	Percentage of population with lower secondary education level per 100,000 population in the region (%)	-	
		D42-3	Percentage of population with high school education per 100,000 persons in the region (%)	+	
		D42-4	Percentage of population with university education or above per 100,000 persons in the region (%)	+	
		D43-1	Number of Buddhist sites in the region (number)	+	
		D43-2	Number of Taoist sites in the region (no.)	+	
	Diversity of Religion（C43）	D43-3	Number of Islamic sites in the region (no.)	+	XII
		D43-4	Number of Catholic sites in the region (no.)	+	
		D43-5	Number of Christianity sites in the region (number)	+	
	Diversity of Language（C44）	D44-1	Number of major circulating dialects in the region (species)	+	XIV
		D45-1	Ratio of household population aged 14 and below to total population in the region (%)	+	
	Diversity of Generation（C45）	D45-2	Ratio of household population aged 15-64 to total population in the region (%)	+	
		D45-3	Ratio of household population aged 65 and above to total population in the region (%)	-	
		D46-1	Share of growth in the number of marriages registered in the region (%)	+	I V
	Diversity of Marital Status（C46）	D46-2	Share of growth in the number of divorces registered in the region (%)	-	
		D46-3	Share of foreign-related marriage registrations in total marriage registrations in the region (%)	+	
		D47-1	Disposable income per capita in the region (yuan)	+	

			D47-2	Share of growth in disposable income per capita in the region (%)	+	
		Diversity of Income（C47）	D47-3	Share of employed population in total population in the region (%)	+	
			D47-4	Number of major foreign-invested enterprises in the region by country (region) (nos.)	+	
		Diversity of Political Appearance（C48）	D48-1	Number of Chinese Communist Party members in the region as a share of total population (%)	+	XV
			D48-2	Total number of Chinese democratic parties in the region as a proportion of the total population (%)	+	
		Diversity of Human Rights（C49）	D49-1	Growth rate of population covered by basic pension insurance for disabled residents in the region (%)	+	I
			D49-2	Number of special education schools in the region (number)	+	
			D49-3	Number of social welfare centers in the region (number)	+	
			D49-4	Number of social welfare hospitals in the region (number)	+	
			D49-5	Number of children's welfare institutions in the region (number)	+	
			D49-6	Number of elderly welfare institutions in the region (number)	+	
			D49-7	Number of grassroots organizations of women's federations in cities, districts, townships, towns and streets in the region (number)	+	
			D49-8	Keyword search index for gender equality in the region	-	IX
			D49-9	Number of social media focusing on gender multiculturalism in the region (number)	+	XVI

Table S5. Three-level indicator composition for Place (B5).

Goal	**Frist-level Indicators**	**Second-level Indicators**	**Third-level Indicators**	**Data Sources**

Cultural Sustainability	Place（B5）	Natural geographic resources（C51）	D51-1	Total annual water resources in the region (billion cubic meters)	+	VII
			D51-2	Surface runoff volume in the region in the year (billion cubic meters)	+	
			D51-3	Yearly per capita water consumption in the region (cubic meters)	+	
		Human Geographic Resources（C52）	D52-1	Number of news reports on artworks using circulating dialects in the region as artistic expressions (articles)	+	XVII
			D52-2	Number of news reports on the region's distinctive culture (articles)	+	
			D52-3	Number of restaurants with local flavor dishes in the region (units)	+	XVIII
			D52-4	Number of restaurants with exotic flavored dishes in the region (units)	+	
			D52-5	Number of restaurants featuring exotic cuisine in the region (units)	+	
			D52-6	Number of dynasties in the region as a historical capital (dynasties)	+	II

Table S6. Three-level indicator composition for Eco-Cultural Resilience (B6).

Goal	**Frist-level Indicators**	**Second-level Indicators**	**Third-level Indicators**			**Data Sources**
Cultural Sustainability	Eco-Cultural Resilience（B6）	Ecological Resilience（C61）	D61-1	Regional annual daily average of sulfur dioxide for the year (mg/m3)	-	I VII
			D61-2	Annual daily average value of nitrogen dioxide (mg/m3) for the year in the region	-	
			D61-3	Average annual concentration of respirable particles in the region (mg/m3)	-	
			D61-4	Number of days with good ambient air quality in the region (days)	+	
			D61-5	Annual good rate of ambient air quality in the region (%)	+	
			D61-6	Percentage of water quality sections of major rivers in the region with water quality class II-III (%)	+	

		D61-7	Percentage of water quality sections of major rivers in the region with water quality class IV-V (%)	+	
		D61-8	Percentage of water quality sections of major rivers in the region with water quality of poor category V (%)	-	
		D61-9	Average Equivalent Sound Level of Regional Environmental Noise in a Year in the Region (dB)	-	
		D61-10	Average equivalent sound level of transportation road noise in the region (dB)	-	
		D61-11	Population density in the region (person/square kilometer)	+	
		D61-12	Green space per capita in the region (square meters)	+	
		D61-13	Growth rate of park green space per capita in the region (%)	+	
		D61-14	Terrestrial wild animals under national key protection in the region (species)	+	
		D61-15	Wild plants under national key protection in the region (species)	+	
		D61-16	Wetland area in the region (10,000 ha)	+	
		D61-17	Area of built-up green space in the region (10,000 ha)	+	
		D61-18	The proportion of growth of built-up green areas in the region (%)	+	
		D61-19	Total Investment in Industrial Pollution, Wastewater and Exhaust Gas Treatment in the Region in the Year (million yuan)	+	
		D61-20	Sewage treatment rate in the region (%)	+	
		D61-21	Garbage disposal rate in the region (%)	+	
		D61-22	Comprehensive utilization rate of industrial solid waste in the region (%)	+	
	Infrastructure and Policy Resilience（C62）	D62-1	Number of environmental emergency alarms received by the ecological environment system in the region in the year (cases)	-	I VIII

			D62-2	Number of emergency shelters in the region in the year (number)	+	
			D62-3	Number of health technicians per 10,000 people in the region in the year (persons)	+	
			D62-4	Number of beds in health institutions in the region (10,000)	+	
			D62-5	Length of long-distance fiber-optic cable lines in the region (10,000 kilometers)	+	
			D62-6	Length of fiber-optic year cable lines in the region (kilometers)	+	
			D62-7	Capacity of local exchange, including access network equipment, in the region (10,000 doors)	-	
			D62-8	Capacity of mobile telephone exchanges in the region (10,000 households)	+	

Table S7. Three-level indicator composition for Eco-Cultural Civilization (B7).

Goal	**Frist-level Indicators**	**Second-level Indicators**	**Third-level Indicators**			**Data Sources**
Cultural Sustainability	Eco-Cultural Civilization（B7）	Publicity, Education, and Cultivation of Ecological Civilization Awareness and Behavior（C71）	D71-1	Regional ecological civilization education search index	-	IX
			D71-2	Cumulative number of ecological environment news in the region published and reprinted by various media (articles)	+	VII
			D71-3	Search index for energy-saving appliances in the region by year	+	IX
			D71-4	Search index of water-saving appliances in the region (year)	+	
			D71-5	No. of letters, calls, visits, net letters, complaints and petitions received by the ecological environment system in the region in the year (pieces)	-	VI VII VIII

	D71-6	Growth rate of gross output value of new energy automobile industry in the region (%)	+	
	D71-7	Number of rail transit lines in operation in the region (Article)	+	
	D71-8	Length of rail transit lines in the region (km)	+	
	D71-9	Number of Ground Public Transportation Vehicles Operating in the Region (10,000)	+	
	D71-10	Number of Ground Bus Lines in the Region (Articles)	+	
	D71-11	Length of Ground Bus Lines in the Region (km)	+	
	D71-12	Number of cabs operating in the region (10,000)	+	
	D71-13	Annual growth rate of total public transportation passenger traffic in the region (%)	+	
	D71-14	Annual growth share of total rail transportation passenger traffic in the region (%)	+	
System for Safeguarding Ecological Civilization（C72）	D72-1	Number of new requests for disclosure of government information received by the Ecological Environment Bureau in the region in the year (pieces)	+	VII
	D72-2	Number of Active Public Government Information Received by the Ecological Environment Bureau in the Region (Articles)	+	
	D72-3	Number of cases investigated and dealt with by the ecological and environmental system in the region in the year (pieces)	+	

D72-4	Number of Penalty Amounts of Cases Investigated and Handled by the Ecological and Environmental System in the Region in the Year (Billions of Yuan)	+

Table S8. Description of data sources for indicators.

No.	Data Sources
I	Statistical Yearbooks of Various Municipalities: Beijing Statistical Yearbook (2014-2021), Shanghai Statistical Yearbook (2014-2021), Tianjin Statistical Yearbook (2014-2021), Chongqing Statistical Yearbook (2014-2021), China Statistical Yearbook (2014-2021)
II	List of Tangible and Intangible Cultural Heritage in Various Municipalities: Representative Items of Intangible Cultural Heritage at the National Level, Representative Inheritors of Intangible Cultural Heritage at the National Level, National Cultural Ecological Reserves, National Demonstration Bases for Productive Safeguarding of Intangible Cultural Heritage, Intangible Cultural Heritage of UNESCO, List of Intangible Cultural Heritage of China Selected for UNESCO (Roster)
III	Ministry of Culture and Tourism of the People's Republic of China: Directory of Mass Tourism
IV	Statistical Yearbook of Culture and Related Industries of Various Cities and Municipalities: Statistical Yearbook of China's Culture and Related Industries (2014-2021)
V	Population Census Data of Various Cities and Municipalities: China 2010 Population Census Data, China 2020 Population Census Data
VI	Statistics Bureau of each city: Economic and Social Development Statistics Bulletin
VII	Official website of ecological environment bureaus of cities and municipalities: Ecological Environment Bulletin
VIII	Official Website of Municipal Government Offices and Units in Various Cities and Municipalities: Open Government Information, Monthly and Annual Work Reports
IX	Baidu Index: Keyword Search
X	Taobao
XI	China Volunteer Service Website: Volunteer Programs and Teams Search
XII	State Administration of Religious Affairs: Religious Basic Information Query System
XIV	Atlas of the Chinese Language: 2nd ed. Beijing: The Commercial Press, 2012
XV	Municipal Party members' education service network, democratic alliances, including the Revolutionary Committee of the Chinese Kuomintang, China Democratic League, China National Democratic Construction Association, China Association for Promoting Democracy, China Peasants, Workers and Democrats, China Zhi Gong Dang, Jiu San Society, and Taiwan Democratic Self-Government League network: Communist Party and Democratic Party Personnel Publication Information
XVI	Sina Weibo; user search
XVII	Official websites of local municipalities: news keyword search
XVIII	Popular Dianping: restaurant search by cuisine

Supplementary Materials S2

Assume that C_{ao} is the sum of the raw values of the n third-level indicators included in the o second-level indicator of the a th city, where a=1, 2, ..., m, m is the total number of sample cities; o=1, 2, ..., n, n is the total number of second-level indicators. Bringing Cao into Eq. (S1) yields r_{ao}, which is the normalized value of the sum of the raw values of the n third-level indicators included in the oth second-level indicator of the ath city.

Subsequently, it is assumed that the raw matrix of second-level indicators in the indicator system is:

$$K = \begin{bmatrix} C_{11} & C_{12} & \cdots & C_{1n} \\ C_{21} & C_{22} & \cdots & C_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ C_{m1} & C_{m2} & \cdots & C_{mn} \end{bmatrix} \tag{S1}$$

The original matrix is normalized using vector normalization to obtain a standardized evaluation matrix $R\left(\left(r_{ao}\right)_{mn}\right)$. Where K is the original evaluation matrix, C_{ao} is the sum of the original values of the n third-level indicators included in the o th second-level indicator of the a th city; R is the standardized evaluation matrix, r_{ao} denotes the normalized value of the sum of the original values of the n third-level indicators included in the o th second-level indicator of the ath city; a=1, 2, ..., and m, m is the total number of sample cities; o=1, 2, ..., n, n is the total number of second-level indicator.

The weights of the indicators determined by the combined assignment of the second-level indicators are taken into account in the evaluation matrix to improve the objectivity and accuracy of the assessment of the cultural sustainability of China's cities. Each row of the standardized matrix can be multiplied by its corresponding weight to get the weighted standardized evaluation matrix $Z\left(\left(z_{ao}\right)_{mn}\right)$. In Eq. (S2), $Q^{*}_{C_o}$ means the combined weight of the o th second-level indicator.

$$z_{ao} = Q^{*}_{C_o} r_{ao} \tag{S2}$$

Assuming that J^{+} is the set of positive ideal solutions, there are:

$$J^{+} = \left\{ max\ z_{ao} \middle| a = 1,\ 2,\ \ldots\ldots,\ m \right\} = \left\{ z_1^{+},\ z_2^{+},\ \ldots\ldots,\ z_m^{+} \right\} \tag{S3}$$

Assume that J^{-} is the set of negative ideal solutions, there are:

$$J^{-} = \left\{ min\ z_{ao} \middle| a = 1,\ 2,\ \ldots\ldots,\ m \right\} = \left\{ z_1^{-},\ z_2^{-},\ \ldots\ldots,\ z_m^{-} \right\} \tag{S4}$$

The distance from the evaluation object to the positive ideal solution is

$$S_a^{+} = \sqrt{\sum_{o=1}^{n} \left(z_a^{+} - z_{ao} \right)^2},\quad a = 1,\ 2,\ \ldots\ldots,\ m \tag{S5}$$

The distance from the evaluation object to the negative ideal solution is

$$S_a^{-} = \sqrt{\sum_{o=1}^{n} \left(z_a^{-} - z_{ao} \right)^2},\quad a = 1,\ 2,\ \ldots\ldots,\ m \tag{S6}$$

Assuming T_a is the a th evaluation object, i.e., the relative affinity of the sample city to the ideal solution:

$$T_a = \frac{S_a^{-}}{S_a^{+} + S_a^{-}},\quad a = 1,\ 2,\ \ldots\ldots,\ m \tag{S7}$$

T_a represents the proximity of the a th sample city to the optimal scheduling level in the range of [0, 1]; the larger the value of T_a, the higher the level of cultural sustainability of

the sample city, and vice versa, the lower the level. Similarly, the relative progress of the a th evaluation object, i.e., the sample city, to the ideal solution of the first or even second-level index can be obtained.