

Supplementary Material

1 Supplementary Figures and Tables

1.1 Supplementary Tables

Supplementary Table 1. Core variables and equations of the subsystems.

Subsystem	Variables	Equations
Population	Total population	$342.85 + \int (\text{Birth population} - \text{Death population})dt$
	Urban population	$\text{Total population} \times \text{Urbanization rate} \times \text{Urbanization process} / 0.7$
	Rural population	$\text{Total population} - \text{Urban population}$
	Per capita carbon emissions	$\text{Total carbon emissions} / \text{Total population}$
Economic	Output value of primary industry	$20.19 + \int (\text{Added value of primary industry})dt$
	Added value of primary industry	$\text{Output value of primary industry} \times \text{Annual growth rate of output value of primary industry}$
	Output value of secondary industry	$418.54 + \int (\text{Added value of secondary industry})dt$
	Added value of secondary industry	$\text{Output value of secondary industry} \times \text{Annual growth rate of output value of secondary industry}$
	Output value of tertiary industry	$454.44 + \int (\text{Added value of tertiary industry})dt$
	Added value of tertiary industry	$\text{Added value of GDP of transportation, storage and postal industry} + \text{Added value of GDP of wholesale, retail and accommodation catering industries} + \text{Added value of GDP in other industries}$

	GDP	Output value of primary industry+ Output value of secondary industry+ Output value of tertiary industry
	Per capita GDP	GDP/Total population
	Carbon emission per unit of GDP	Total carbon emissions /GDP
Energy	Energy consumption of domestic water	Unit energy consumption of domestic water ×Domestic water
	Energy consumption of production water	Unit energy consumption of production water×Production water
	Energy consumption of water	Energy consumption of domestic water+ Energy consumption of production water
	Energy consumption of sewage discharge	Unit energy consumption of sewage discharge×Total effluent discharge
	Energy consumption of sewage reuse	Sewage reuse×Unit energy consumption of sewage reuse×0.8/Sewage reuse technology
	Energy consumption of reclaimed water	Unit energy consumption of reclaimed water×Reclaimed water
	Energy consumption of water conveyance	Domestic water×Conveyance coefficient of domestic water+ Production water×Conveyance coefficient of production water+ Ecological water×Conveyance coefficient of ecological water
	Water-related energy consumption	Energy consumption of water+ Energy consumption of water conveyance+ Energy consumption of sewage discharge+ Energy consumption of sewage reuse+ Energy consumption of reclaimed water
	Energy-related water consumption	(Water consumption of coal+ Water consumption of oil+ Water consumption of natural gas+ Water consumption of electricity)

	Water consumption of coal	$(\text{Coal consumption} \times \text{Unit water consumption of coal}) / 10000$
	Coal consumption	$\text{Total energy consumption} \times \text{Proportion of coal}$
	Carbon emission of coal	$\text{Coal consumption} \times \text{Coefficient of carbon emission of coal}$
	Carbon emissions of energy consumption	$\text{Carbon emission of coal} + \text{Carbon emission of oil} + \text{Carbon emission of natural gas} + \text{Carbon emission of electricity}$
Water	Domestic water for urban residents	$\text{Urban population} \times \text{Urban per capita annual water consumption} \times 0.5 / \text{Water-saving policy}$
	Domestic water for rural residents	$\text{Rural population} \times \text{Rural per capita annual water consumption}$
	Domestic water	$\text{Domestic water for urban residents} + \text{Domestic water for rural residents}$
	Agricultural water consumption	$\text{Total output value of agriculture} \times \text{Water consumption per unit agricultural output value} \times 1 / \text{Coefficient of the effective utilization of water}$
	Industrial water consumption	$\text{Total industrial output value} \times \text{Water consumption per unit output value of secondary industry}$
	Water consumption of tertiary industry	$\text{Output value of tertiary industry} \times \text{Water consumption per unit output value of tertiary industry}$
	Production water	$\text{Agricultural water consumption} + \text{Water consumption of secondary industry} + \text{Water consumption of tertiary industry} + \text{Energy-related water consumption}$
	Water consumption	$\text{Domestic water} + \text{Production water} + \text{Ecological water}$

Domestic sewage discharge	Domestic water×Discharge coefficient of domestic sewage
Production wastewater discharge	Production water ×Discharge coefficient of production wastewater
Total effluent discharge	Domestic sewage discharge + Production wastewater discharge
Sewage treatment	Total effluent discharge×Sewage treatment rate
Sewage reuse	Sewage treatment×Sewage reuse rate
Carbon emission of irrigation	Effective irrigation area×Coefficient of carbon emission of irrigation water
Carbon emission of domestic sewage	Domestic sewage discharge×Coefficient of carbon emission of domestic sewage
Carbon emission of production wastewater	Production wastewater discharge×Coefficient of carbon emission of production wastewater
Carbon emission of water consumption	Carbon emission of domestic sewage+ Carbon emission from production wastewater+ Carbon emission of irrigation
Total carbon emissions	Carbon emissions of energy consumption+ Carbon emission of water consumption

Supplementary Table 2. Results of the analysis of the effectiveness of the SD simulation model.

Year	Population/ (10000 persons) (Relative error %)			Economic output/ 100 million yuan (Relative error %)		Water/ 100 million cu.m (Relative error %)		Energy/ 10000 tons of SCE (Relative error %)	
	Tp ^a	Up ^b	Rp ^c	Pi ^d	Si ^e	Dw ^f	Pw ^g	Twc ^h	Tec ⁱ
2005	0.00	-0.01	0.05	0.00	0.00	-0.01	-0.67	-0.41	0.00
2006	0.04	0.09	-0.17	0.00	0.00	0.06	-0.61	-0.25	0.00
2007	-0.10	-0.15	0.11	0.00	0.00	-0.12	-0.60	-0.41	0.00

Supplementary Material

2008	0.09	0.10	0.07	0.00	0.00	0.09	-0.65	-0.38	0.00
2009	0.02	0.00	0.14	0.00	0.00	0.01	-0.63	-0.40	0.00
2010	-0.06	-0.11	0.17	0.00	0.00	-0.10	-0.71	-0.45	0.00
2011	-0.06	-0.12	0.20	0.00	0.00	-0.09	-0.79	-0.34	0.00
2012	-0.01	0.05	-0.32	0.00	0.00	0.00	-0.78	-0.44	0.00
2013	0.12	0.10	0.21	0.00	0.00	0.11	-0.72	-1.66	0.00
2014	-0.01	0.01	-0.17	0.00	0.00	0.00	-0.69	-0.24	0.00
2015	0.02	0.01	0.05	0.00	0.00	0.02	-0.69	-0.53	0.00
2016	0.10	0.14	-0.20	0.00	0.00	0.09	-0.69	-0.21	0.00
2017	-0.04	-0.06	0.05	0.00	0.00	-0.05	-0.74	-0.50	0.00
2018	-0.04	-0.07	0.17	0.00	0.00	-0.05	3.32	1.90	-1.05
2019	0.11	0.11	0.13	0.00	0.00	0.11	0.03	0.12	-2.19
2020	-0.10	0.01	0.05	0.00	0.00	0.07	-0.69	0.10	-1.10
2021	0.01	0.01	0.03	0.00	0.00	-0.10	-0.70	0.01	-0.97

Notes: ^a Total population; ^b Urban population; ^c Rural Population; ^d Primary industry; ^e Secondary industry; ^f Domestic water; ^g Production water; ^h Total water consumption; ⁱ Total energy consumption.