Study on the Measurement of Climate Capacity and Its Health Effects in Xi'an City

Li Peng[1, 2, 3]

[1]International Business School, Shaanxi Normal University, Xi'an 710119, China

[2]School of Economics and Management, Northwest University of Agriculture and Forestry Science and Technology, Shaanxi Province, Yang-Ling City, 712100, China

[3]Department of Agricultural Economics, Extension & Rural Development, University of Pretoria, Pretoria, South Africa

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Abstract: Combining the multi-disciplinary backgrounds, using the comprehensive evaluation method of entropy weight, Nemero index method, regression method and causal analysis, etc., the index system is constructed to measure the climate capacity of Xi'an. In addition, the health effects of climate capacity residents are explored. The results show that the overall climate capacity of Xi'an shows a slight fluctuation trend, but both are lower than the base year climate capacity value, and its climate system is obviously vulnerable. Then, the health effects of climate capacity were further explored, and the results confirmed that climate capacity had a significant effect on health effects. Comprehensive consideration of the theory and application of the environmental library Zinets curve, urban development should break through the vicious circle of “development - environmental pollution - redevelopment - environmental re-contamination” under the guidance of traditional development concepts, but also national, local, social and personal Multi-agent participation and collaborative innovation.

1. Introduction

Climate capacity is a new concept proposed to adapt to the continuous changes of the global climate. It refers to the maximum capacity of climate resources, climate environment and their changes in a certain area to enable coordinated and sustainable development of population, economy, society and natural ecology. The proposal of this issue is based on three considerations. First, in recent years, due to the continuous strengthening of human activities, the climate risks faced by global urban development have been rising, and the complexity of human-ecosystem has also increased. Second, adapting to climate change is listed as a special chapter of the National 13th Five-Year Plan. Third, if Xi'an wants to become a national central city, an international comprehensive transportation hub, and an international metropolis with historical and cultural characteristics, the personnel will be more intensive, the resources will be more tight, and it will be extremely vulnerable to extreme climate events caused by climate change. The impact, especially on people's physical health is a great threat. Therefore, this paper measures the climate capacity of Xi'an and evaluates its health effects, with a view to the climate dilemma that Xi'an faces in the process of building into a national central city, an international comprehensive transportation hub, and an international metropolis with historical and cultural characteristics Put forward some feasibility suggestions to provide theoretical and data support for the sustainable development of Xi'an.

2. Literature Review

In recent years, some domestic research concepts related to urban climate issues have been proposed in China, and the concept of “climate capacity” is also here[1-2]. And the economics of

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climate change, which has developed rapidly in recent years, shows the necessity of adapting climate change to my country's economic development. Some scholars analyzed the meteorological and remote sensing data for 20 years in northern China, and the results showed that temperature increase and precipitation reduction were the main factors affecting the primary productivity of the ecosystem in the region, and the contribution to the decline in primary productivity was as high as 90% It is climate change, and the impact of land use change is only one-tenth [3]. China is a special country among developing countries in the world. Although it has a vast territory and rich products, it has a large population base. On the one hand, it is “development deficit”: insufficient development imbalance, and “adaptation to deficit”: adapting to global changes, double-strike On the other hand, natural resources such as geography, climate and land also seriously restrict population growth and economic and social development. The main contradiction in our country has become the contradiction between the people’s growing need for a better life and unbalanced and inadequate development. In view of China's basic national conditions, it is necessary for us to conduct some deeper thinking on further adapting to climate change and promoting the sustainable development of China's economy and society, and exploring theories and methods that are more in line with China's actual national conditions and solve China's real problems. Therefore, this article takes this as the research direction, and combines it with the health effect innovatively. Taking Xi'an as an example, it analyzes its connotation, research methods, theoretical basis and policy implications, and how to circumvent Xi'an's urban development and construction. The climate dilemma faced in the process of cosmopolitan metropolis put forward some suggestions, scientific and quantitative assessment of the role of climate conditions in supporting socio-economic activities and maintaining the health of ecosystems. In this case, the indicator of climate capacity can be more reliable Measure these capabilities.

Quantitative analysis and evaluation of the climate capacity of Xi'an City to study its impact on the health of citizens. On the one hand, it can provide sustainable development for Xi'an City in terms of technology and decision-making. On the other hand, it is also expected to be a promoter and practitioner of the research process of urban climate capacity in China.

3. Research Methods, Indicators Selection and Data Sources

(1) Research methods: Calculation of urban climate capacity

This article uses the research methods of Yan Shengjun [4] to build an evaluation index system, finally uses these three criteria layer data to construct an evaluation function to calculate the climate capacity of Xi'an.

The Nemero index method has the advantage of highlighting the impact and role of core elements in evaluating natural climate capacity, and is more objective than other methods:

$$CNC = \sqrt{\frac{\overline{P}^2 + P_{\max}^2}{2}} \qquad (1)$$

In equation (1), *CNC* is the natural climate capacity index; P_{max} is the maximum value of the capacity of each element of the climate; $\overline{P}$ is the average value of the capacity of each element.

Based on the evaluation of the natural climate capacity index *CNC*, the urban climate pressure index *CCP*, and the urban coordinated development capacity index *CDA*, plus the definition of its climatic capacity in this article, the urban climatic capacity function is finally constructed as follows:

$$CCI = f(CNC, CCP, CDA) \qquad (2)$$

Among them, *CCI* stands for urban climate carrying capacity index; according to the properties of *CNC* and *CCP* (smaller is better) and *CDA* (larger is better), the following functions are constructed:

$$CCI = \frac{CDA}{CNC \cdot CCP} \quad (3)$$

Obviously, *CCI* is an index with a larger value, which is better. In a mathematical sense, it is equivalent to the target year's climate carrying capacity compared to the base year's climate carrying capacity. If *CCI*> 1, it means better than the target value; if *CCI* <1, it means that the target value has not been reached.

(2) Data source and index system construction

1) Data Source

The climatic capacity index data of Xi'an from 2006 to 2016 are mainly from the “Xi'an Statistical Yearbook”, “Shaanxi Statistical Yearbook” and “China City Construction Statistical Yearbook”. The two indicators of health effects for 2006-2016 are mainly from the “China Health and Family Planning Statistical Yearbook” and the “Shaanxi Health and Family Planning Yearbook”.

2) Index System Construction

This article strictly builds in the comprehensive evaluation index system of climate capacity, a total of 25 indicators in 3 criteria layers are retained (see Table 1). Due to the rationality and availability of data Sexuality and health effects are mainly measured by the proportions of health care expenditure in total consumption expenditure and respiratory disease mortality.

Table 1 Climatic Capacity Evaluation Index System

Indicator layer		Criterion layer	unit
Natural climate capacity	1	year average rainfall mm	mm
	2	Average wind speed	m/s
	3	Average temperature	℃
	4	Extreme maximum temperature	℃
	5	Extreme minimum temperature	℃
Urban climate pressure	6	Unemployment rate	%
	7	GDP per capita	Yuan/person
	8	Road area per capita	m²/person
	9	Comprehensive daily water consumption per capita	m³/person
	10	City population density	person/km²
	11	Elastic coefficient of energy consumption	%
	12	Urban cars for urban residents Per 100 households	Per 100 households
	13	Energy consumption per unit of GDP	Ten thousand yuan
	14	Area of completed housing per capita	m²/person
	15	Total industrial output value	100 million yuan
	16	Engel coefficient of urban households	%
	17	Total industrial exhaust emissions	100 million m³
	18	Number of medical beds per 1,000 people	general classifier
	19	Water resources available per person	m³/person
	20	per capita use of land resources	m²/person
Urban coordinated development capacity	21	GDP growth rate	%
	22	Total investment in environmental pollution treatment	100 million yuan
	23	Science and technology expenditure	100 million yuan
	24	Total education expenditure	100 million yuan
	25	Green area per capita	m²/person

4. Data Analysis of Climate Capacity and Health Effects in Xi'an

(1) Measurement of climate capacity

According to formulas (1) and (6), Xi'an's natural climate capacity index *CNC*, urban climate pressure index *CCP* and urban coordinated development capability index *CDA* are calculated respectively. First, determine the weight values of the urban climate stress index *CCP* and the urban coordinated development capability index *CDA*, and then obtain the *CCI* value of the Xi'an 2006-2016 climate capacity index and the measurement results of each indicator. Figure 1 is a graph showing the changes in the climate natural capacity index of Xi'an, the urban climate pressure *CCP*, the city's coordinated development capacity *CDA*, and the climate capacity index. Specifically, Xi'an's Climate Natural Capacity Index experienced a relatively stable-volatility decline-rapid rise process during 2006-2016, while the Climate Natural Capacity Index is a reverse value. The climatic conditions have actually been in a state of declining fluctuation for several years, and the reason why the natural climate capacity in 2016 deviated greatly may be that the extreme minimum temperature index value deviated severely from the reference climate reference value in that year; The U-shaped curve continued to decline from 2006 until the minimum value in 2012 was less than 0.5. During the period, from 2008 to 2009 from 1.01 to 0.52, the decline was the largest. It rebounded slightly from 2009 to 2010, and continued to decline until 2012. 0,41, but since 2012, the index value has been increasing almost linearly, and the overall signs show a U-shaped development, which has a great relationship with the rapid urbanization and energy consumption structure of Xi'an in recent years; Xi'an's coordinated development capacity There was a slight increase in 2006-2007, followed by a slight decline in the following year, a sharp decline in the two time periods of 2008-2009 and 2010-2011, and even a decline of 0.5 between 2008-2009, which remained stable during 2009-2010, that is to say From 2007 to 2011, there was a continuous downward trend, and it reached the lowest value in 2011, and then showed a continuous growth trend, reaching a peak of 1.63 in 2015, followed by a downward trend in the following year; Xi'an 2006-2016 Climate Carrying Capacity Index Although there is a large fluctuation state, although the overall trend is still rising, it is still lower than the target value and still at a low level, reflecting that the climate situation in Xi'an in recent years is actually not optimistic, and the climate in Xi'an is relatively speaking Capacity is more affected by its own environmental changes and has obvious vulnerabilities, which is also related to the frequent occurrence of extreme climate events and the urban heat island effect in recent years.

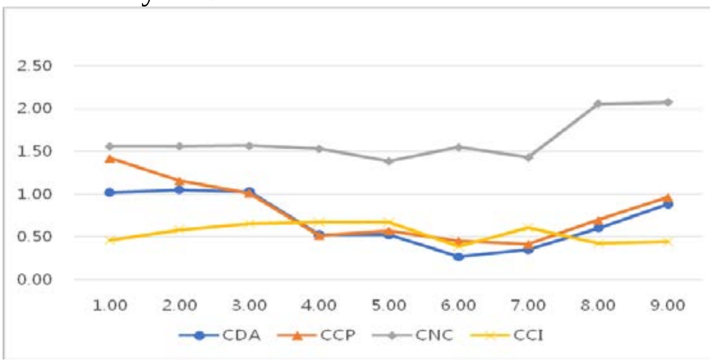

Fig.1 Xi'an Climate Natural Capacity Index Cnc, Urban Climate Pressure Ccp, Urban Coordination Graph of the dynamic change of development capacity *CDA* and climatic capacity index

(2) Analysis of health effects

1) Regression analysis

This article selects the proportion of health care expenditure to total consumption expenditure and the climate capacity index as the dependent and independent variables for regression to discuss the impact of climate change on residents' health. And with the help of the method used by Li Peng et al. (2013)[5] in exploring the relationship between forest carbon sinks and economic growth, explore the relationship between climate capacity and health effects .

It can be seen that climate capacity has an impact on the proportion of health-care expenditure in total consumption expenditure. From the regression results, the proportion of health care expenditure in total consumption expenditure will change with the change of climate capacity, and this change is positive, that is to say, the proportion of health care expenditure in total consumption expenditure increases with climate capacity With the increase, the climate capacity of Xi'an City has a positive impact on the health of residents in this city. The greater the climate capacity, the greater the proportion of people's health care expenditure in total expenditure. The more health care costs, the higher the corresponding health level, indicating improvement Climate conditions have a positive impact on the physical and mental health of residents.

2) Unit root detection of *CCI* and *C*

In order to enhance the reliability of the test conclusion, ADF and PP unit root test methods are used in this paper to test the unit root test of the variable original sequence, first-order difference sequence and second-order difference sequence. The test statistics and their *P* valuesare shown in Table 2. It is comprehensively recognized that CCI is first-order single-integer, and C is second-order single-integer, namely CCI-(I1) and C-(I2).

Table 2 Unit Root Detection Results of Cci and C (Including Trend and Intercept Items)

Inspection method	ADF		PP	
	Statistics	P-value	Statistics	P-value
CCI	-3.317	0.1212	-3.460	0.1003
∆CCI	-4.273	0.0414	-4.477	0.0234
∆2CCI	-7.101	0.0058	-10.559	0.0003
C	-2.569	0.3003	-2.03	0.5159
∆C	-2.335	-2.585	0.2952	0.3790
∆2C	-13.377	0.0002	-6.970	0.0040

(3) Long-Term Equilibrium Relationship between Health Effects and Climatic Capacity-Co-Integration Test 0.3790

The unit root test results show that the second-order difference sequences of *CCI* and *C* are both stable, so there is a high possibility that there will be a long-term equilibrium relationship between *CCI* and *C*. This paper uses the Johansen Fisher method to perform a cointegration test on the lagging second-order data of *CCI* and *C*. The results show that: at a significant level of 10%, the null hypothesis *CCI* and No cointegration relationship between *C* is rejected, so there is a cointegration relationship between *CCI* and *C*, that is, there is a long-term equilibrium relationship between climate capacity and health effects.

In order to clarify the long-term equilibrium relationship between climate capacity and health effects, this article uses the OLS regression method to perform cointegration regression on the data. The regression estimation results are as follows:

$$C_{t-2} = 0.045 + 0.066CCI_{t-2} + e_t \tag{4}$$

Equation (4) is the long-term equilibrium relationship between climate capacity and health effects, that is, the co-integration equation. The regression results show that the climate capacity has a promoting effect on the health effect (the regression coefficient is positive, and the t value is also positive), and through the significance test at the 5% level, the health effect will increase for every unit increase in the climate capacity 0.066 units, which is in line with the reality of the relationship between climatic capacity and health effects.

A unit root test was performed on the residual sequence et of the regression results. The results showed that at a 1% significance level, the residual sequence was stationary, that is, there was no unit root. Therefore, the co-integration relationship between the variable Ct-2 and the variable CCIt-2 exists.

(4) Error Correction Model

The results of the co-integration test on climate capacity and health effects and OLS estimates indicate that there is a long-term equilibrium relationship between climate capacity and health effects in Xi'an. However, due to the inconsistency of the statistical caliber of the “Xi'an Statistical Yearbook” around 2005 and the difficulty of data collection before 2005, the data available in this article is only nearly 10 years of data, and the time span is short. Therefore, in the short term, there may be an imbalance. In order to enhance the accuracy of the model, the error term et in co-integration regression is regarded as an equilibrium error, and the short-term effect between climate capacity and health effect is established by establishing a modified error model. Connect with long-term changes. The model settings are as follows:

$$\Delta C_{t-2} = \alpha + \beta \Delta CCI_{t-2} + \gamma E_{t-1} + \mu_t \quad (5)$$

Among them, E is the error correction term. Using Eviews 8.0 to take a direct estimation method to estimate the error correction model. Since the coefficient of the error correction term cannot be positive, but the data error correction term coefficient shown in the figure is 1, the error correction model does not exist, which indicates that there is no deviation in the long-term equilibrium relationship between climate capacity and health effects.

Table 3 Error Correction Model Results

Variable	Confidence factor	standard error	t statistic	P value
C	0.045163	3.36E-16	1.34E+14	0.0000
CCI(-1)	0.066204	5.92E-16	1.12E+14	0.0000
E(-1)	1.000000	8.41E-15	1.19E+14	0.0000

Note: *C* in the figure represents a constant, and *C* (health effect) mentioned in the article is not a variable.

It is not difficult to find: Xi'an's climate natural capacity index is a reverse index, its fluctuation range is large and shows an obvious growth trend, Xi'an's climate capacity is significantly restricted by the climate's natural capacity, and its climate system's vulnerability is obvious; urban climate The pressure fluctuations show a U-shaped curve. Although the overall trend is a downward trend, the urban climate pressure index has continued to increase in recent years, which is exactly the opposite of the climate capacity change trend, indicating that climate constraints on Xi’an’s social and economic development are becoming more and more obvious; cities Overall, the coordinated development capability has shown an increasing trend and a good growth trend in recent years, indicating that its role in improving the climate capacity of Xi’an has been strengthened; the proportion of health care expenditure in total consumption expenditure and the regression of the climate capacity index is significant, indicating that health care The proportion of expenditure to total consumption expenditure increases with the increase of climate capacity. Although the overall climatic capacity in Xi'an has increased slightly, it is lower than the value of the climatic capacity in the base year, and it is fluctuating due to the large amount of natural climate capacity in Xi'an.

5. Suggestions

Through the study of Xi'an's climate capacity measurement and its health effects, this paper proposes the following climate dilemmas faced by Xi'an in the process of building into a national central city, an international comprehensive transportation hub, and an international metropolis with historical and cultural characteristics. Make some suggestions for coordinated sustainable development.

5.1 National level

Actively promote the improvement of relevant laws and regulations, and increase the enforcement of environmental protection. New opportunities will arise in the new environment, as well as new problems. We can actively promote the Air Pollution Control Law to keep up with the trend of the times and meet the needs of sustainable development in the new era. At the same time, the law enforcement of environmental protection will be strengthened, and high-pollution enterprises that violate the law and exceed the standards will be severely punished. At the same time, it is also possible to levy higher taxes , as well as policy subsidies for clean energy.

Establish a regional linkage mechanism centered on Xi'an to allow regions with similar climatic capacity to jointly cope with a series of impacts caused by changes in climatic capacity. Actively carry out a series of researches related to climate change and health effects, explore prediction models and early warning systems for severe weather and health effects, formulate corresponding countermeasures, establish a public communication platform for climate change and health risks, enhance public awareness of prevention, mobilize all citizens to participate, strengthen International cooperation and exchanges to jointly address climate change.

5.2 Local level

First of all, Promote the upgrading of industrial structure. Although Xi'an can be said to be a large and medium-sized city, its production methods are still relatively backward compared to other developed regions, and it is necessary to constantly improve the industrial structure and optimize the regional industrial chain. With the help of the existence of its superior scientific research institutes and the development of existing high-tech industrial parks High-tech industries can not only promote the development of Xi'an industrial structure to a high degree of breadth, but also improve the climate and environmental problems caused by traditional industrial production methods. Secondly, Promote the upgrading of energy consumption structure. By reducing the proportion of coal resources in primary energy consumption and increasing the proportion of clean energy to adjust the entire energy structure, economic means are more effective than administrative means. Thirdly, Vigorously develop the tertiary industry with Xi'an characteristics. The modern logistics service industry has very great development prospects in the tertiary industry, but due to the limitations of development level and technical level, there are still many problems such as low distribution efficiency and insufficient scale, and the climate and environmental problems caused by these problems are also very serious.

5.3 Social Level

Enterprises and institutions are the main body of market participation, and they should have a strong sense of environmental responsibility. However, only a very small number of Chinese companies have a sense of social responsibility. This situation makes clean energy development face greater difficulties. We should not follow the old path of pollution first and then governance as developed countries. The health loss caused by pollution is irreversible. The sacrifice at this time will not be just environmental damage for a period of time. The goal pursued by our enterprise should not only be profit maximization, but should aim at maximizing the synergy between profit and responsibility, and assume its due responsibilities.

5.4 Personal Level

As far as the long-term layout of climate capacity is concerned, the power of the individual is small, and the personal consumption gains in terms of the environment are basically insignificant in the short term. But for individuals, the impact of the environment is huge. In addition to the health effects measured in the article, the environment will have a subtle impact on all aspects of personal physical and mental development. Everyone is responsible for protecting the environment. The things that individuals can do are small, but the accumulation of less is more. We should fully understand the importance of the environment to individuals and take practical actions to protect the environment.

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