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# City Character Evaluation Based On Human Settlement

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**Abstract:** This paper discusses the relationship between three human settlement evaluation indicators and city character by regression analysis, based on the 120 American cities with more than 100 thousand people. Finally, this paper gets a mathematical model with SPSS software and discusses the relationship between science factor and human factor in human settlement quantitatively to supply a general theoretical foundation for social management and city planning.

**Keywords:** Human Settlement; City Character; Evaluation Indicator; Regression Analysis

## 1. Introduction

With the rapid development of global urbanization, the problem of urban environment, inhabitants' health, community security is under threaten. As a result, city human settlement has attracted great consideration worldwide. To develop the human settlement level and to improve the inhabitants' quality of life is the target of city planning. Human settlement generally refers to the summation of all the material and non-material which constitute the condition for subject survival and development in certain human centered space.[1]Human settlement is the hot issue in academia for now, involving population, resource, environment social, economic and other aspects in the physical space of human life, containing geography, environment, ecology, philosophy, art, folklore, history, construction, psychology, society, economy, transportation and many other disciplines.[2]In the human settlement system, human factor which refers to the habitats' thinking and behavior will be defined as city character in this paper. Taking the United States as example, we select 120 cities with more than 100 thousand people as the study objects, try to do some preliminary quantitative analysis on human settlement evaluation indicators and city character evaluation indicators, and build the mathematical model at last.

## 2. Evaluation Indicator Model

### 2.1. Choosing Human Settlement Evaluation Indicator

Since human settlement is affected by many factors, selection of the evaluation indicator must be objective, scientific and effective. Therefore, on the basis of the previous studies,[3][4] considering the practical experience in the process of data collection, the paper has summarized the principle of human settlement evaluation indicator selection.

*1) Principle of target*

The evaluation should target at people orientation, involve in habitation and life related elements, reflect people's objective and subjective feelings and need for human settlement, thus to make the evaluation actual and credible.

*2) Principle of comparability*

Try to select comparable indicators.

*3) Principle of comprehensiveness*

The chosen indicators should involve in habitat condition, ecological environment, economic condition, social environment and other sorts of indicators to respect all aspects of human settlement without omission.

*4) Principle of operability*

The chosen indicators should be collectable and expressed quantitatively to make sure the calculation regarding to the complexities of the human settlement system.

*5) Principle of timeliness*

The indicators that reflect stability and dynamic should be opportune. Also, the human settlement construction process is not static but constantly developing and changing, so the evaluation indicator system should be adjustable to adapt to the characteristics of different periods of urban development, and to reflect the development trend of human settlement.

Based on the above principles and the selection method by Feng Zhiming[5], the paper chooses topographic index , temperature and humidity index, water resource index in natural factors and city character index in human factors as the human settlement evaluation indicators for study.

### 2.2. Building the Human Settlement Evaluation Indicator System

*1) Topographic index model*

Relief degree of land surface, short for RDLS, refers to regional level altitude and comprehensive characterization of the earth cutting surface. Based on the study of Niu Wenyuan[6] and the paper of China terrain degree's correlation to population distribution by Feng Zhiming[7], the RDLS index is defined as:

$$RDLS = \frac{ALT}{1000} + \left\{ [Max(H) - Min(H)] * \left[ 1 - \frac{P(A)}{A} \right] \right\} / 500$$

Where RDLS is the relief degree of land surface, ALT is the regional average elevation calculated at grid size, Max(H) and Min(H) represent the highest and lowest altitude, P(A) is the flat area, and total area of the region, which is defined as by the maximum height difference less than 30m of 15Km2 space in this paper, A is the total area of the discussed region.

*2) Temperature and humidity index model*

Referring to the temperature and humidity index computing formula by Thorn (1959)[8], the temperature and humidity index short for THI is designed as:

$$THI = 1.8t - 0.55(1 - f)(1.8t - 26)$$

Where THI is the temperature and humidity index, t is the average temperature( ) of each month and f is the monthly average relative humidity(%).

*3) Water resource index model*

Based on the method of building the hydrological index model by Li Xin[9], the hydrological index short for WRI is defined as follows:

$WRI = a\,P + b\,W\,a$ WRI=

where WRI is water resource index, P is normalized precipitation ; W is normalized water area, and represent weight of precipitation and water area respectively, valued as 0.8 and 0.2.

### 1.3. Building the City Character Evaluation Indicator System

In this paper, the city character is equaled to the habitats' character which is reflected on the thinking and behavior method of the habitats. For analysis and discussion, the calculation formula of city character index short for CCI is defined as follows in this paper:

$$CCI = a\,C + b\,M + g\,E$$

Where CCI is the city character index, C is the urban crime index, M is the urban marriage rate E is the urban unemployment rate, α, β, γ represent weight for C, M and E which can be obtained from the weight of their corresponding correlation value with average life span in each studied city. The corresponding correlation value is shown in table 1.

**Table 1. Corresponding Correlation Value and Weight of CCI Indicators with Average Life Span**

| | Corresponding Correlation Value | Weight |
|---|---|---|
| C | 0.331 | 0.18 |
| E | -0.935 | 0.49 |
| M | 0.630 | 0.33 |

## 3. Data Sources

Data used in this paper are obtained from The U.S. Cities Network Statistics (part by calculating), Wikipedia and the Data Center for Resources and Environmental Sciences of the Chinese Academy of Sciences. Value in table 2 is calculated by taking data into the above models(set 5 for example).

**Table 2. Human Settlement Evaluation Indicator Value**

| City | RDLS | THI | WRI | CCI |
|---|---|---|---|---|
| Bakersfield ,CA | 812.82436 | 31.16036 | 1.1336 | 7.7898 |
| Atlanta ,GE | 19.3394 | 28.90813 | 3.808 | 10.7848 |
| Clarksville, TE | 55.155 | 25.93212 | 3.82 | 8.2947 |
| Bend, OR | 893.2473 | 15.9944 | 0.86736 | 6.7774 |
| Athens, GE | 2.3914 | 30.16188 | 5.64664 | 8.2406 |

## 4. Method of Analyzing Human Settlement Indicator

In this paper, stepwise regression is the main measure for human settlement evaluation quantitative analysis. Stepwise regression is a modern regression method based on multiple regression, and its basic idea is to build multiple regression equation by screening of each factor, which will be introduced one by one by the condition that the partial regression sum of squares upon examination is remarkable. Meanwhile, each new-introduced factor should be individually tested and the non- significant partial regression sum of squares factors should be removed until no new factor is introduced. By stepwise regression method, we can get the significant evaluation for the city character and their corresponding correlation value from which we know the importance of each evaluation indicator for city character.

Deviation formula:

$$d = \lim_{n\to\infty} \sqrt{\frac{1}{n}\sum_{i=1}^{n} d_i^2} = \lim_{n\to\infty} \sqrt{\frac{1}{n}\sum_{i=1}^{n} (1_i - X)^2}$$

The formula is for the deviation, mean and Pearson coefficient to measure the strength of linear correlation between the variable(RDLS, THI, WRI) and the Dependent variable(CCI). The data are analyzed and calculated by software of SPSS, and the results are shown in table 3.

**Table 3. Variables Entered/Removed**

| Mode | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | RDLS，THI，WRI | | enter |

All requested variables entered.
Dependent variable: CCI

Table 4 lists the sum of squares, freedom, mean square, F and its significance test.

Table 5 lists the unstandarized coefficients of variable RDLS, THI and WRI and their significance test.

Multiple linear regression matrix form:

$$\begin{cases} y = X\beta + \varepsilon \\ E(\varepsilon) = o, Var(\varepsilon) = \delta^2 I_n \end{cases}$$

**Table 4. ANOVA**

| Model | Sum of squares | df | Mean square | F | Sig. |
|---|---|---|---|---|---|
| regression | 6.577 | 3 | 2.192 | 1.020. | 0.605a |
| residual | 2.149 | 1 | 2.149. | | |
| total | 8.726 | 4 | | | |

a Predictors: (Constant), RDLS，THI，WRI
Dependent variable：CCI

**Table 5. Coefficients**

| Model | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|
| 1 | B | Std.Error | Beta | | |
| Constant | 11.488 | 5.887 | | 1.951 | 0.301 |
| RDLS | -0.006 | 0.005 | -1.836 | -1.264 | 0.426 |
| THI | 0.080 | 0.138 | 0.334 | 0.581 | 0.665 |
| WRI | -1.014 | 1.071 | -1.388 | -9.47 | 0.517 |

a.Dependent variable: CCI

Where In is unit matrix of order n, is the Summation parameter vector, X is design matrix, is n-dimensional vector of random errors. Regression analysis regression equation is

$$Y = 11.488 - 0.006RDLS + 0.08THI - 1.014WRI$$

By equation analysis of variance and regression coefficients significant test, we build a significant regression equation.

## Conclusion and discussion

The paper analyzed the five randomly selected American cities' human settlement evaluation indicators and designed the mathematical model mainly based on the data from the U.S. Cities Network Statistics (part by calculating). From the regression equation model we can conclude that since the difference in terrain features, climate features and hydrological features, the inhabitants' characters are different, and their relation can be expressed quantitatively by mathematical model. This paper analyzed nature factors' middleweight action to human factors by the designed mathematical model, in hope to provide a universal theory of reference for social management, urban planning and behavioral medicine.

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