Study on Balance of Urban Datum Land Price Among Cities Based on GIS Platform, In Sumedang District of West Java Province of Indonesia

Achmad Rizal and Isni Nurruhwati

Abstract— The research aims at establishing system of urban land grade and datum land price of Sumedang District in Indonesia, which shows regional difference of land quality and land price level. The production of this research will provide important reference in constituting macro policy of regional land planning and promote balanced harmonious development of land transaction. Based on analysis of advantage and disadvantage of research methods in existence, the paper introduces the technology process of urban land gradation and how to balance urban datum land price of different cities and towns. Balance of urban datum land-price is based on urban land gradation, principal component analysis enhances selection of evaluation factors and confirmation of weights. K-Means clustering by distance is used to enhance the efficiency of land gradation. In the instance of Sumedang District in Indonesia, research methods have been improved. Based on land gradation, We propose the method of zoning by regional economic development level to determine reasonable capitalization rate and capacity rate. By establishing linear regression equation or exponential regression equation between score of evaluation units in land gradation and sample points of transaction, we can balance urban datum land price, modify abnormal land price. Based on GIS platform, Information system of balancing urban datum land price is developed to gather, store and analyze index system of factors in urban land gradation and information of land transaction. Map of datum land-price is compiled to show the trend of urbanization level of different cities.

Index Terms— land gradation; balance of datum land price; GIS platform; clustering analysis..

1 Introduction

Urban areas are home to around 65% of the Indonesian population and the main driver for economic growth and innovation, but their further sustainable growth represents a challenge both for internal management and planning as well as for the surrounding environment (land, soil, biodiversity) within the urban fringe and far beyond.

Land take by the expansion of residential, industrial/commercial and construction areas and the associated sealing of surfaces is the main cause for the increase in the coverage of urban land at European level. Agricultural zones and, to a lesser extent, forests and semi-natural and natural areas are disappearing in favor of the development of artificial surfaces (Erb KH, 2012). This affects biodiversity since it decreases habitats, the living space of a number of species, and fragments the landscapes that support and connect them. Land take and soil sealing further decrease the availability of valuable soil functions (e.g., biomass and raw material provision, storing and filtering of substances, or acting as biodiversity pool) (Burgi et.al, 2004).

Reliable information on the extent and dynamics of land take by urbanisation and infrastructure development as well as soil sealing is a primary requirement for a range of environmental policies. The urban land is the carrier of all activities in a city. The city development is reflected by the change of the land to a great extent, and it is particularly true under the market economy condition (Knox PL, 1991). In order to study city competitiveness, we can take urban land as core and analyze the influencing factors, such as the maturity degree of urban land market and urban land use benefit, etc, and then undirectly evaluate the city competitiveness.

Urban land gradation can reflect the difference of land quality among cities. For the moment, evaluation of urban land grade is executed based on Regulation of urban land grading and Regulation of urban land valuating. Because of the difference of the definition of datum land price, the difference of technique of datum land price evaluation, the difference of the accuracy of material, the comparison of datum land price between towns is not quite available. Balancing datum land price and land grade aims to build a reasonable factor system and datum land price system in Sumedang District in Indonesia.

2 Materials and Methods

According to the tables made by the ministry of land and resources of Depelopment Planning Agency at Sub-National Level of Sumedang District and technique group, we collect and fill the factor data from 26 independent towns (subdistrict) in Sumedang District, land grading and datum land price evaluating have been done in the 26 independent towns. There are 13 forms including 52 data items. Besides the material which can reflect the rate of economic increase, the data collected should be the latest data, at least including the data of the nearest three years (2014-2016). Material about land grading factors, latest results about land grading and datum land price evaluation, datum land price tables and land transaction material should be collected mainly.

Land gradation is based on multi-factors integrated judging and clustering analysis etc. By analyzing the material, analyzing the factors which may influence land quality, consider-

ing the difference between areas, we can confirm the index system of factors. Then we use principal component analysis to confirm the factor system. According to the principal component analysis, we select location condition, agglomeration scale, utilities, ecological environment, regional service capacity, infrastructure, input-output level of urban land, regional economic development level, regional land-provision potential. After the above statistical analysis, experts' advice should be considered to improve the definition of factors system of land gradation in Sumedang District , establishing weights of factors according to the Delphi Method as well.

The land gradation in Sumedang District uses multi-factor integrated judging method and the following two methods to validate datum land price. 1) at first, revise all the datum land price material of every town, and then adjust the gradation results based on the sequence of datum land price and gradation results by multi-factor analysis; 2)using effective K-Means clustering analysis, take towns as clustering objects, and take weights of factors in the gradation process as overall weight of the clustering objects, then calculate the distance between objects, clustering analysis should be done according to the distance. How to adjust the gradation results by multi-factor integrated judging method and validation process is vital to balance of datum land price.

We introduce the modified K-Means clustering method to validate and revise the original result of urban land gradation. When using multi-dimensional spatial clustering, we should consider both the proximity of locations and the similarity of attributes. (X_i,Y_i) represents a point's location and $Z_i = (Z_{i1}, Z_{i2}\ldots Z_{in})$ represents serial attributes of the point. Thus the generalized Euclidean distance, represented with D_{ij}, has following ways of definition.

1.Treat attributes comparably with spatial coordinates.

$$D_{ij} = \sqrt{(X_i - X_j)^2 + (Y_i - Y_j)^2 + \sum_{k=1}^{m}(Z_{ik} - Z_{jk})^2}$$

2. Weight the distance of attributes and geometry separately.

$$D_{ij} = W_a\sqrt{(X_i - X_j)^2 + (Y_i - Y_j)^2} + W_p\sqrt{\sum_{k=1}^{m} W_k(Z_{ik} - Z_{jk})^2}$$

3. Weight each component of spatial coordinates and attributes separately.

$$D_{ij} = \sqrt{W_x(X_i - X_j)^2 + W_y(Y_i - Y_j)^2 + \sum_{k=1}^{m} W_k(Z_{ik} - Z_{jk})^2}$$

In the first place, data needs dimensionless processing to avoid influences from different units of indicators, the sum of weights should be 1.The paper uses K-Means Clustering Analysis Method for urban land gradation based on generalized Euclidean distance of the second meaning.

K-Means clustering method is used to verify urban land gradation, every gradation unit is considered as point in 9-dimensional space, we use score of nine Level-1 factors of gradation units from sequence method to do clustering analysis. The algorithm is illustrated by figure 1.

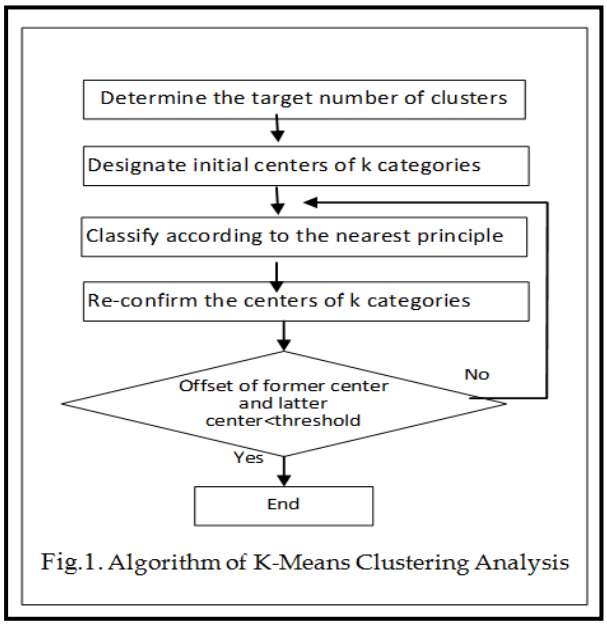

Fig.1. Algorithm of K-Means Clustering Analysis

3 Results and Discussions

Firstly, we establishes the definition of the datum land price balancing, and then modify land exploitation degree, appraisal date and capacity rate of the balancing units. Furthermore, we should renew the datum land price of the cities. Then, on the basis of the similarity degree among the land market data, urban land gradation and the urban datum land price, we select typical cities as the datum land price control points. According to the urban land grade and land price of control cities, we use the piecewise linear interpolation to balance the land price, and apply statistical analysis and spatial analysis methods to validate the results.

In 2012, as an experimental unit, West Java province had made the study on urban land gradation and the balance of urban datum land price. The same study had been done in Banten province later. The present methods have the disadvantages as follows: the uniform capacity rate and capitalization rate is used in the whole experimental region, not considering the difference among the regions in economic development and land market development. The present balancing methods and verification methods emphasize the relationship between land gradation value and datum land price, not considering rationality of spatial distribution of land price and regional development.

We propose the method of establishing capitalization rate and capacity rate by regional integrated economic level And then it improves the piecewise linear interpolation, on the basis of improved piecewise linear interpolation, the paper presents the method of validation by piecewise regression analysis model and spatial interpolation.

Considering the regional difference in economic development and land market development, we get 5 equal-value subdistricts in Sumedang District by gradation results and datum land price, and we establish the uniform capitalization

rate and capacity rate for each unit. Because Sukagalih and South Sumedang have no comparability to other cities in Sumedang District , Sukagalih and South Sumedang can be treated as a separate unit in use of its own capitalization rate and capacity rate. We can divide the other cities into four units as developed cities, middle-developed cities, normal cities and undeveloped cities in Sumedang District .

After the division of subdistricts, we can get the capacity rate of units by calculating the average value of capacity rate in gradation units. And the establishment of capitalization rate is based on investigation of ratio between rental and sale in districts. Basic parameters of datum land price in Sumedang District is in the table 1 below.

TABLE 1
BASIC PARAMETERS OF DATUM LAND PRICE IN SUMEDANG DISTRIC

Unit	Grade	Commerce land		Industry land		Housing land	
		capacity rate	capitalization rate	capacity rate	capitalization rate	capacity rate	capitalization rate
A	1	2.6	8.69	1	6.6	1.8	7.19
B	3	1.7	7.931	0.9013	6.568	1.609	6.96
C	5	1.6014	7.665	0.833	6.571	1.3738	6.75
D	7	1.131	7.12	0.656	6.368	1.106	6.5

The objects of datum land price balancing is the modified land price, such as modified high price, middle price and low price. We aim at the high land price and then calculate the middle and low price according to constant intervals. We select the typical cities as the control points and do piecewise linear interpolation based on the score of land gradation. The balancing formula is:

$$P_i = P_0 - \Delta N_i (P_0 - P_n)/(N_0 - N_n)$$

P_i is balanced outcome of a city's high single datum land price; P_0 is high single datum land price of former control point; P_n is high single datum land price of latter control point; ΔN_i is difference to gradation score of former control point; N_0 is gradation score of former control point; N_n is gradation score of latter control point.

There are two shortages in current method of balancing urban datum land price. The current method uses urban land gradation to regulate the single datum prices (commerce, housing, and industry), the disaccord between the two types of data precision will lead to unsatisfactory balanced results of some cities.

This method does not consider regulating datum land price in aspects of regional spatial structure of economic development, central cities' capacity of concentration and diffusion. For example, the total score of Jatinangor is 88, Tanjungsari 82, the grade of them is 2, the grade and score reflect the level of commerce and housing land price of two cities very well. But for industry land, the result is not very ideal, Jatinangor is a city of heavy industry, has a high level of industry land price, the highest industry land price is 574 USD, in Tanjungsari, commerce and agriculture rather than industry is the dominant industry, industry land price is lower than the average level, the lowest is 262 USD, the gradation score can not reflect the level of industry land price very well.

If we sort cities in Sumedang District by integrated score of gradation and high datum land price of certain use,about fifteen percent of cities can be chosen as control points, integrated score of gradation and high datum land price of certain use in these cities have the similar trend, but datum land price based on piecewise linear interpolation will lead to inaccuracy of balanced land price in some cities.

In the paper, control cities are selected by integrated score of gradation and high datum land price of certain use after standardization. At first, we balance general datum price of the control cities, and then weights of commerce, housing and industry are established, as well as the balance of land price of each land type.

If the high value of general datum price after balance in Jatinangor is X, we suppose high value of commerce datum price after balance is X_1, high value of housing datum price is X_2, high value of industry datum price is X_3, weights of commerce,housing and industry which indicate their influence on general datum price are W_1,W_2 andW_3, the ratio of high value of commerce, housing and industry after balance is $P_1 : P_2 : P_3$, then:

$$X = X_1 * W_1 + X_2 * W_2 + X_3 * W_3;$$

$$X_1 : X_2 : X_3 = P_1 : P_2 : P_3$$

Based on two formulas above, high values of land price of commerce, housing and industry after balance can be obtained,as well as other values of land price.

At first, we use regression analysis to validate the balanced result of urban datum land price, build regression equations, take land market transaction sample points (or revised high-value of urban datum land price) and general score of land gradation into regression analysis and then calculate the urban datum land price of cities according to the regression model. Linear or exponential model can be selected according to the urban datum land price-score diagram. Based on the equation, we can do calculation for balance of datum land price, then compare them with the balanced result from piecewise linear interpolation. We take the gradation score as X-axis and take the high-value of general price as Y-axis,, then according to the distribution and characteristics of the plot diagram, results of regression analysis is used to compare the results from two methods, and correct abnormal land price. Figure 2 shows the comparison between piecewise regression analysis and regression analysis.

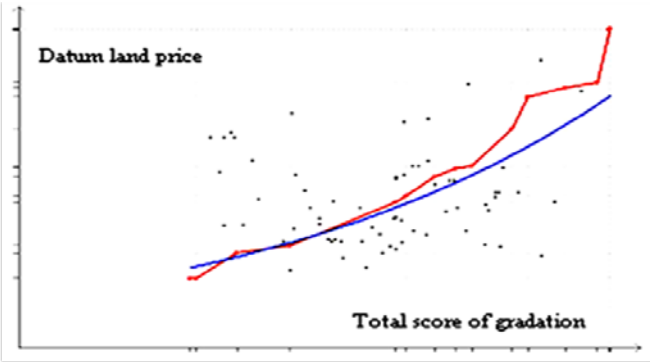

Fig 2. comparison between piecewise linear interpolation and regression analysis

The results of balance of datum land price among cities will be submitted to Land and Resources Bureau in cities for advice. Advice from local experts who are familiar with land market and datum land price, and validation results by regression analysis, spatial analysis lead to the final results of balance of datum land price.

According to datum land price among cities after balance (commerce high-value, commerce mid-value, commerce low-value, housing high-value, housing mid-value, housing low-value, industry high-value, industry mid-value, industry low-value), and by statistical analysis, we establish the other nine indicators of each grade such as the average value and control range. Because of the number of cities and grades, we need to identify control range of datum land price of each city by gradation score and datum land price after balance.

By making use of complex computation, spatial analysis of GIS and geographic statistical analysis, urban land gradation, balance of datum land price, validation and the dynamic monitoring and update of land price are integrated in the system.

Balance of datum land price among cities establishes system of datum land price, as well as the quantitative statistical features of datum land price and spatial distribution patterns. Based on GIS platform, map of gradation and datum land-price among cities of Sumedang District, visually reflects quantitative characteristics and spatial distribution, and objectively expresses the economic development of Sumedang District. Urban land gradation map is shown in figure 3.

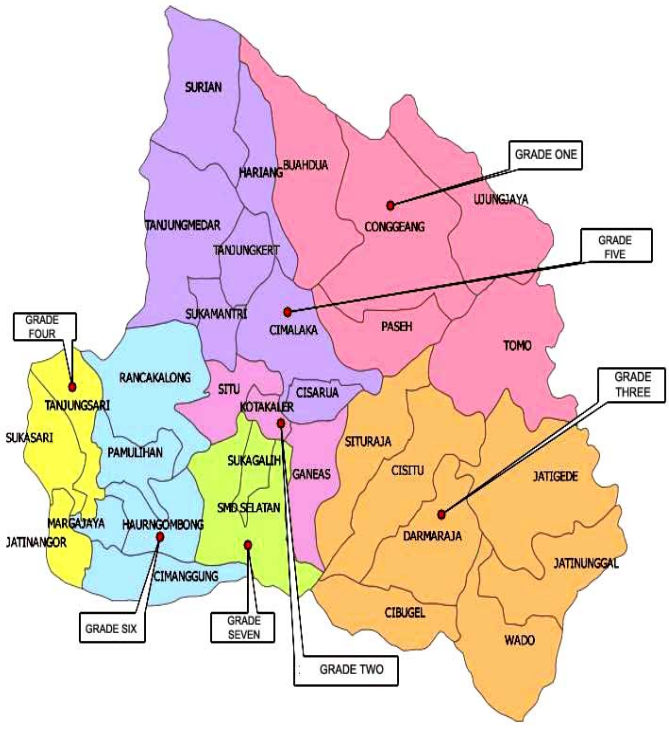

Fig.3.Urban land gradation map of Sumedang District

4 Conclusion

In this paper, capacity rate and capitalization rate are established according to regional economic level, improved piecewise linear interpolation and piecewise regression analysis model are applied in the research of urban land gradation and balance of datum land price. Sequence relationship between general gradation value and standardized datum land prices is considered in this research, not considering regional economic development structure and capacity of concentration and diffusion from central cities.

In order to investigate the essence of diversity of land price among cities, future work will be how to confirm affective ranges of central cities and land price diffusion regularity, and then select central cities by regional pattern and city quality, balance of datum land price of central cities will be established at first, the balance of datum land price in other cities can be calculated by land price diffusion equations.

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