Research on Land Development Intensity Control Based on GIS Multi-Dimensional Model

Jing Luo *
Dianchi College, Yunnan University, Kunming, China

*Corresponding author e-mail: reegine@qq.com

Abstract: This paper takes the central city of Malone as an example to establish a basic database of GIS and construct an urban land development intensity control system. Research on the introduction of land mass potential, economic benefits, human settlements and other factors, from different dimensions to establish a benefit model, economic model, environmental model, comprehensive determination of the study area control intensity indicators. The conclusion shows that the area with high strength F of grid unit development is located in the south of Malong Old Town, the most part of the east-west main road and the adjacent areas in the east and west. From the overall F-value spatial distribution, the development intensity of the southwest is suitable for a higher floor area ratio (FAR). Secondly, the development intensity of the northwestern region is suitable for a relatively low construction floor area ratio (FAR).

1. Introduction

In the process of urban reconstruction and construction, the low intensity of land development leads to the rapid expansion of urban land and the serious waste of land resources. If the intensity of land development is too high, it will bring about adverse effects such as the decline of urban environmental quality. Whether it is predatory, extensive development or high intensive, high-intensity development methods, it will affect the long-term sustainable development of the city.

Zhang Bo et al. (2010) analyzed the factors affecting the intensity of land development in the central area, including traffic location, commercial location, and historical landscape protection [1].

Yin Gui (2010) proceeded from the understanding of the regional characteristics of the old urban areas, evaluated the existing methods for determining the development intensity indicators, and used the advantages and weaknesses to integrate and form a method system for the development of urban old district development intensity based on the economic perspective [2].

Huang Yuqin (2011) studied from four aspects: economic analysis method of development intensity, prediction and distribution of total development amount, formation of floor area ratio (FAR) range, and linkage control of development intensity index [3].

From the research results in recent years, the intensity control methods of urban land development often cut from a single perspective, which is more common from the perspective of economic perspective and location value. The research uses GIS analysis methods to iterate from the three dimensions of development potential, economic input-output balance and landscape environmental conditions under the influence of location, and scientifically control and measure the intensity of land development [4,5,6].
2. Status of the study area
The research object of this paper is the planning and construction land area of the central urban area in the urban planning of Malong District, Qujing City, Yunnan, with an area of about 14 square kilometers.

![Figure 1. Location of Malone District](image1)

3. Land development intensity control based on big data multidimensional model

3.1. Model construction
Through the establishment of the GIS basic database of Malong District, the paper establishes the efficiency model and economy model through the three dimensions of land use efficiency, economic benefit and human settlement environment, through the location value of the soil, the input and output of the construction, and the planned urban design of the key sections. The model and the environmental model are used to construct the Malone urban development intensity control system in the role and feedback of the three-dimensional models (the action and feedback methods are as shown in the lower left figure). Based on the efficiency model, the economic model and the environmental model are used to correct and feedback, to get the results of the study.

![Figure 2. Research technology roadmap](image2)
3.2. **Basic status survey**

According to the status quo of urban development in Malong District, the urban planning scope is divided into several grids according to the two levels of large and small, the basic information is investigated, and the current building information is comprehensively surveyed and GIS information is stored. The large lattice is generally a street divided by roads, with an area of about 30-50 hectares. The small lattice is a subdivision of blocks in the neighborhood, with an area of about 8-10 hectares. Conduct research on the status of land use and building information for the existing grid. The census of building information in the built grid includes the number of building layers, structural forms, main colors, façade materials to be used for the cost measurement of demolition and construction under the economic dimension.

![Figure 3. Basic status survey scope](image)

In addition, according to the Malone city plan, the study divides the urban urban planning area into $10 \times 10$ m land use units for the GIS space calculation and simulation of the model in three different dimensions.

3.3. **Efficiency Dimensions: Measurement of Land Development Potential**

The study evaluates the land development potential within the scope of the study based on the urban planning of the Malong District. The index system is divided into three levels, namely the basic factor layer, the derivative factor layer and the factor layer, and the spatial development potential under the influence of each factor is translated and calculated and spatially superimpose the calculation results of each factor.

| Basic feature layer | Derived factor layer | Factor layer | Description |
|---------------------|----------------------|--------------|-------------|
| Core location       | Centrality of the lot (C) | Centrality of business (C1) | The impact of commercial centers on urban land quality. |
|                     |                      | Traditional Business Center (C2) | |
|                     |                      | Cultural Education Facilities (V1) | |
| Facility configuration | Public service facilities (V) | Medical service facility (V2) | Residents' recreation, children's education and medical convenience and level. |
|                     |                      | Recreational Sports Facilities (V3) | |
| Livable condition   | Landscape quality (L) | Park Green Space (L1) | Habitat environment conditions can attract more citizens to work and live here. |
Considering the feedback between the total amount of buildings under the potential model and the building capacity of the forecasting area in the urban planning period, the study emphasizes the constraint coordination of the total amount of the planning on the forecasting quantity of the model, and the average value of the grid unit construction and the space efficiency of the area under the influence of the total amount of development. The values are correlated, the development intensity potential value is simulated, and the floor area ratio spatial partition of the study area is further formed, thereby avoiding the overload problem of the land development.

The development strength of the plots under the efficiency dimension is shown in the figure below. From the perspective of the spatial distribution of the reference floor area ratio $F_s(i)$, under the influence of the potential factors of the efficiency dimension, the large-scale development areas of Malong City are mainly distributed in the traditional commercial street area of the old city and the middle section of the east-west urban main road.

![Figure 4. Reference floor area ratio distribution map](image)

3.4. Economic Dimension: Constraints and Amendments of the Market Economy

The study uses the input-output model to calculate the minimum economic floor area ratio of the plot according to the benchmark land price, the current construction situation, the land development cost, and the profit rate of the central urban area of Malong District. The minimum economic floor area ratio is calculated through the input of the current urban real estate development cost and the output of land development in Malong City. In this study, the development intensity of the plot under the economic dimension is combined with the development intensity under the environmental dimension.

1) The determination of urban real estate development cost includes: 1 land acquisition fee, 2 demolition and resettlement cost, 3 construction security cost, 4 infrastructure supporting expenses, tax and financing costs, and 5 housing sales expenses.

When adopting the input-output theory for economic analysis, the total output of land development includes not only the costs that the developer should recover, but also the industry profits that the developer deserves.

Namely: total input $\times$ profit margin = total output - total investment

2) Estimation of the lowest economic floor area ratio under the established land price

$$F_s(i) = \frac{F_s(S-aP_2)+(P_1-F_sB*S)}{S-(P_3+P_4+b*S) (1+r)}$$  \hspace{1cm} (1)
F(e)-the lowest economic floor area ratio of the plot, Fx-the current plot ratio of the plot; P1 - land transfer unit price, P2 - demolition and resettlement compensation unit price, P3 - Jian'an cost unit price, P4 - other development cost unit price (including infrastructure support fee, urban development tax, three-year development cycle financing cost, etc.), S-home sales Unit price, a-debt ratio coefficient, b-cost of sale factor, r-margin rate.

3.5. Environmental Dimensions: Urban Design Constraints and Fixes

The study corrects the factors of human settlements, strengthens coordination with urban design requirements for land parcels, avoids over-emphasizing efficiency and economy, and sacrificing the one-sided approach to human settlements.

Malong Longhu Lake is one of the “Five Lakes” in Qujing City and an important environmental landmark in Qujing City. According to the urban design of the Longhu Lake area in Malong District, the Longhu area will be built, “One Lake, Three Districts, Three Nuclear and Nine Gardens”, becoming an urban landscape oasis that blends modern landscape with natural humanities.

The study combines the urban design scheme of the Longhu area, which has a key section of Malong, and determines the floor area ratio of the plot city according to the factors of human settlements.

![Figure 5. Urban Design of Longhu Area](image)

Calculate the lowest economic floor area ratio Fe(i) under economic efficiency and the urban design floor area ratio Fd(i). If Fe(i)> Fd(i), to ensure the economic feasibility of land development, take the lowest economy. The floor area ratio Fe(i); If Fe(i)= Fd(i), the suitable floor area ratio Fa(i) can be both; if Fe(i) < Fd(i), the urban design floor area ratio is taken as The unit is suitable for a plot ratio Fa(i).

The calculation results of the ideal floor area ratio Fa(i) under the influence of the economic floor area ratio Fe(i) and the urban design floor area ratio Fd(i) are shown in the figure below. From the perspective of the spatial distribution of the suitable plot ratio Fa(i), under the influence of the economic dimension and the environmental dimension, the distribution of the urban development higher intensity plots is relatively scattered, involve the existing urban design, the relatively dense construction of the urban center, the plot of better current situation and the area with relatively high floor area ratio.
Figure 6. Appropriate plot ratio map

4. Conclusions and discussion
The study divides the analysis results of three different dimensions according to the priority principle of land potential-oriented, economic priority, and human settlement. The grid reference floor area ratio $F_s(i)$ in the efficiency dimension is compared with the appropriate floor area ratio $F_a(i)$ in the economic and environmental dimensions to generate a grid unit development intensity value $F$.

Figure 7. Final plot ratio map

The conclusion shows that the area with high strength $F$ of grid unit development is located in the south of Malong Old Town, the most part of the east-west main road and the adjacent areas in the east and west. From the perspective of the $F$-value spatial distribution of the whole city, the southwest development The strength is suitable for a higher floor area ratio, followed by the middle, and the development intensity in the northwest is suitable for a relatively low construction floor area ratio.

Based on massive data information, this paper establishes and improves the measurement model from the perspective of GIS multi-dimensional and quantitative. It systematically and scientifically determines the development intensity index and enhances the overall, scientific and forward-looking nature of land development in urban planning and management. Has strong necessity and practical significance.
Acknowledgments
Yunnan Provincial Department of Education Research Fund Granted (Item Number: 2018JS739), Research on Development Strength Control of Malong County Central District Based on Multidimensional Modeling of Big Data.

References
[1] Zhang Bo, Ge Yousong, Gu Mingdong. Study on the intensity of land development in urban central area——Taking the old city of Nanjing as an example, J. Journal of Hebei Normal University (Natural Science Edition), 2010, 03: 359-364.
[2] Yin Gui. Research on the intensity control of urban old district development based on economic perspective, D. Chongqing University, 2010.
[3] Huang Yuqin. Research on “indentation” of development intensity in controlled detailed planning, D. Xi’an University of Architecture and Technology, 2011.
[4] Zhou Liya, Zou Bing. Discussion on the technical method of multi-level control of urban density——The main idea of “Shenzhen Special Economic Zone Density Zoning Study”, J. Urban Planning, 2004, 12: 28-32.
[5] Huang Ning, Xu Zihong, Xu Shasha. Empirical Research and Dynamic Optimization of Urban Construction Land Strength Control in Wuhan, J. Urban Planning Journal, 2012, 03: 96-101.
[6] Alonso, W., 1964, Location and Land Use, Cambridge, Published by Harvard University Press.