LOWLAND TECHNOLOGY INTERNATIONAL Vol. 15, No. 2, 56-65, December 2013
International Association of Lowland Technology (IALT), ISSN 1344-9656

A QUANTIFICATION ANALYSIS OF SUBURB LAND USE AND CONSTRUCTION INTENSITY BASED ON AFAR: A CASE OF THE LAND DEVELOPMENT AROUND ZIJINGANG CAMPUS, ZHEJIANG UNIVERSITY

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ABSTRACT: China is facing an increasing urbanization in the edge area surrounding main metropolises. This paper targets at analyzing the construction mechanism of land use planning near suburban college towns. Theories and methods such as typical case analysis, mathematical model, and space capacity analysis were used to quantify the mechanism. A typical suburban block, Zijingang Campus Town of Zhejiang University was taken as the case. Since the key index (floor area ratio) indicates the construction intension of a patch of land, it is necessary to examine its appropriate range. The analysis result shows that there are differences in architectural prosperity and urban function by means of several designs. According to the guidelines of urban master planning and urban detailed plan, the Appropriate Floor Area Ratio (AFAR) calculated and deduced based on Economic Floor Area Ratio (EFAR) and Max/Min Floor Area Ratio (MFAR) can be useful in ratifying land development intensity, predicting future tend and evaluating city planning projects.

Keywords: suburb; land development; floor area ratio; college town

INTRODUCTION

With the spatial diffusion of some central cities, suburb regions gradually become mature and closely linked with the central areas (Allison and David 2008; Jana and Luděk, 2010; Phelps, 2010). During the period of simultaneous development between the outer edge areas and urban centers, those surrounding regions become new layers that show no longer a traditional sense of the suburbs. Land and property development processes obviously can be seen as a social situation and have proposed the measurement of a development site's ecological performance (Samsura et al. 2010; Ferguson and Friday 1983; André 2000). The evolution of suburban and urban spatial structure is related to the stage of development. In the 1980s and 1990s, the phenomenon of population and industry spread to the outskirts appeared in Beijing, Shanghai and other large cities. It led to the imbalance of suburban land use structural, improper land development intensity and the loss of land assets.

Universities help to propel the country toward the era of the post-industrial society, and have impact on R&D, economic et al (Harold 1970; Irwin 1990; Jan and Philip 2008). Many suburban areas held the residential suburbanization and received the opportunities of universities' migration. These areas not only need to solve contradictions with their own development, but also need to take full use of university resources to promote regional prosperity. It can contribute to interaction relationship of resident, scientific research, commerce and university with land distribution. It also can guide the surrounding region to adapt and assist the university R & D, and exert the driving effect of universities. While determining the appropriate land development intensity is good to improve regional living environment, urban form and the efficiency of land use.

In "The overall planning of Hangzhou City (2001-2020)", the western Hangzhou which was surrounded by Zijingang campus is used as education, scientific research district and residential area. This paper is based on the development of western Hangzhou, through the research of the land use analysis, spatial distribution, the relationship between Zhejiang University and the surrounding area; calculating the floor area ratio of the

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Note: Discussion on this paper is open until June 2014

analysis area; and finally get a reasonable mode and construction intensity of suburb land.

DISCUSSIONS

Suburban Land Use under the Evolvement of Urban Spatial Structure

The main impact on land use patterns are still government policies and market-based. Metropolitan coordinating region growth theory and international experience show that when metropolitan coordinating region grows to the development and expansion phase, metropolitan spatial structure should be changed from the core circle mode to the ribbon multi-center paradigm timely for guiding the sustained, coordinated and healthy development of metropolitan space. The rapid economic development changes transportation, location, policy etc(Carol 2010), and the underlying formation of regional development corridors in Yangtze River Delta region breaks the original balance of regional spatial structure, further more bringing big changes to suburban spatial structure, and generating new requirement of urban development. This requirement changes from the original form of concentric circles expanded and turns into dispersive groups and axial dispersion patterns. Eventually form a ribbon city and realize a great-leap-forward development.

Currently, Hangzhou gradually converts the mode of simplex center around the West Lake circular to a multi-center morphological structure with an evenly balanced periphery: surrounded by Zhejiang University Campus and Xixi Wetland, surrounding the West Lake and along Qiantang River. The west of city centers on Zijingang Campus and Xixi wetland, relying on the nicer nature environment and human environment. The surroundings congregate many scientific research and information industries, and form knowledge-intensive business offices area.

Suburban High School Construction and Surrounding Land Development

The use of college construction and surrounding land not only inseparably linked to the space, but also closely related with their functions. The president of Yale University Levin noted that the university can make a contribution to directly improving the local economy development, the "neighborhood" (the school around) relations, public education, health caring, social services and environmental awareness by community construction and intellectual support (Qiu and Zhao 2006).

Different functional units are relying to varying degrees of renting and research-oriented universities. According to the level of dependence, the rank from high to law is commercial office space, high-tech industrial R & D space, labor-intensive high-tech industry development space, living space and a new agricultural space (Zheng and Matthew 2008; Sun 2000). Universities can exert their spillover effects by integrating and using university resources, distributing surrounding land rational, and defining the integrative location of collecting scientific research, residential, commercial, office services. The spillover effects promote regional structural transformation with combining different factors (e.g. research, development, universities, business, politics and various financial institutions). It also can achieve the development of regional innovation and economic which based on knowledge and technology. It is significant to create a new urban growth point and improve the efficiency of suburb land's output by seizing the opportunities of college construction, arranging reasonable layout of undeveloped space's function, and determining the appropriate floor area rate. Thus, it is necessary to determine the appropriate floor area of resident, commerce, and scientific research from the overall economic efficiency, environmental benefits and space shape.

METHODS

The Current Use of Land around Zijingang Campus, Zhejiang University

The analysis area belongs to the surroundings of Zijingang Campus, Zhejiang University. Zijingang Campus is located in the west of Hangzhou and divided into two parts. The eastern part has come into use, while the western part is on the preparation for construction. Both the south and north sides of Zijingang Campus are surrounded by Sandun and Jiangcun Residential District. The west side doesn't have any extensive constructions at the moment, while residential district is the primary function and commerce is supporting facilities by the east side (Fig. 1). Because of the lag of government's macro management, the urban spread brings intensive building and serious lack of large-scale facilities in suburb area. An intensively resident region has formed in Jiangcun and Tangbei, and the block of Jiangcun is relatively mature. While the Tangbei region is still in the suddenly growth of urban development stage and facing

many problems, such as shortage of facilities, lack of open space et al.. At present, it has not yet formed any education base, high-tech industries hatch base, and venture base that combined production and research.

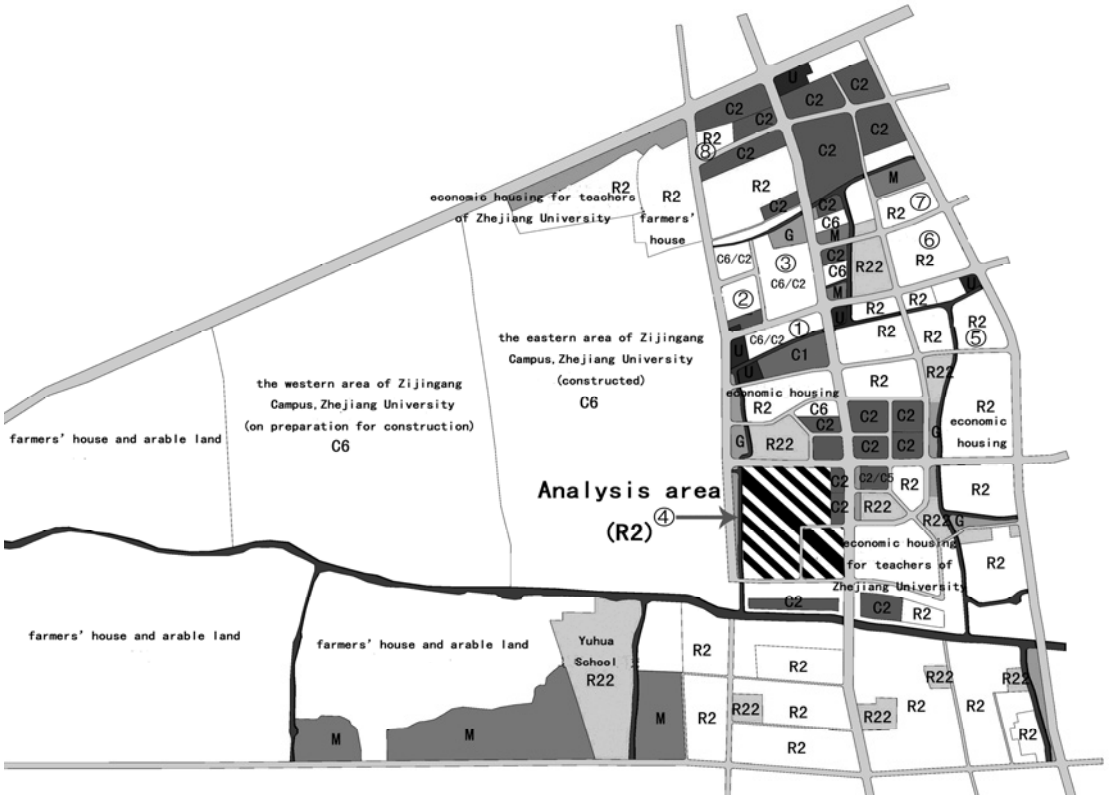


Fig. 1 Land use planning around Zijingang campus

An Analysis about the Interaction Mechanism between Zijingang Campus, Zhejiang University and the Surrounding Land Use

The Effect of Zijingang Campus to the Surrounding Land Use

Universities create demands for the city actively, forming a close economic relationship with the surrounding regions that can gain developing opportunities by providing various services for the Universities. The most significant influence of Zijingang Campus, Zhejiang University had on the surrounding land use is the external positive effect of building campus to real estate.

House prices are usually affected by the different ground rent, forming descending trend from the city center to the outskirts (Bo and Chung 2010; Zhu 2010). The price of the house around Zijingang Campus is forming a zonal high price residential district along Zijingang Campus and Xixi Wetland. House price mainly centralizes in the district around Zhejiang University and gradually decreases as the distance away from Zhejiang University being further and further. Especially the small high-layer, high-layer and townhouse whose FAR are between 2.2~2.6. The house prices are inversely proportional to the distance to Zijingang Campus (Table 1). The house price of Wendingyuan next to Zhejiang University is the highest that sufficient reflects the research-oriented university's promoting effect on the surrounding (Table 2). The obvious space differentiation reflects on the section of house prices is not in accordance with the law of diminishing rent. Therefore, there is no doubt that campus has a boost on the surrounding region and urban overall development. Moreover, it produces a positive effect ----Institute Real Estate. It makes the surrounding house prices develop with spheres type and brings positive effect on the surrounding land's functions and urban environment. This area becomes the regional core and creates a foundation for an ever-higher price.

Real Estate Developers Occupy the Additional Value of Zhejiang University's Resource

According to conceptual planning of the areas around Zhejiang University, Zijingang Campus the core of western city will be constructed as education base, high-tech industries hatch base, and venture base that combined production and research. It is also the center of tourism, commerce and public service in northwest of

the city. Zijingang Campus has intensive intellectual resources, high-class hardware facilities and abundant public resources (such as playgrounds, libraries, activity centers, public green space and canteens, etc.). The additional value of the land that formed by these advantages have become instrument to get profit with real estate developers. It is difficult to satisfy the requirements for the innovative promotion. The surrounding is enveloped by many real estates (viz. such as Wendingyuan Community, Jianqiao Community, Shengyuan Community and the West City Time Community) and can't meet the needs of scientific research. It also cannot offer enough practice opportunities for undergraduates. College resources have not form industrial incubation space and the training space of campus human resources. Real estate developers mostly occupy all kinds of resources and positive factors. It bates the attraction of university on urban areas, graduates and professionals.

Table 1 A list of the community groups around Zijingang campus

Name of the Community Groups	Floor Area Ratio	Distance from Zhejiang University(M)	Average Price (Yuan per s.m.)	Land Usage	Remark
①Jianqiao Community	3.5	200	8500	C6/C2	Open Groups with Six Multi-Layer and High-Layer; Small Elite Digs、Street Commerce.
②Creative Industry Region	1.7	250	5800	C6/C2	Office Buildings, Commerce, Flat, Multifunctional Commerce Center, Lead-in MOHO Idea.
③Zijin Square Community	3.5	400	11000	C6/C2	Three Buildings with Ten Layers: One Layer underground, Four Layers of Commerce over Ground.
④Wendingyuan Community	2.5	700	20000	R2	Small High-Layer and High-Layer; Equip an Elementary School in the Community.
⑤Shangjun Community	2.5	900	17000	R2	/
⑥The West City Time Community	2.6	950	14000	R2	High-Layer.
⑦The West City Villa Community	2.2	1000	17000	R2	Townhouse, High-Layer.
⑧Tianyi Mansion Community	3.0	1100	11600	C2	/

Notes：the Distance is Calculated from the Center of this Land to the Gate of Zhejiang University
(Origin of Dates：Community Information [ED/OL], http://hz.soufun.com/)

Table 2 The price evolution of Wendingyuan

high-rise	year	average price
new house	2005.5	RMB:7900
	2007.9	RMB:9298
	2009.5	RMB:16500
second-hand house	2013.4	RMB:23529

The Reasonable Land Layout around Universities

Research-oriented universities are strongly attracted and radiated to the main city centers. In addition, the space that connected research-oriented universities and city centers have changed. According to domestic and international experience, research-oriented universities and its surrounding areas have some common basic features (Yang et al., 2006). One is a combination of high-tech industrial bases, innovation centers and higher education bases. The second is a new growth pole which regards research-oriented universities as the new regional center and the new growth space of city. The third is structural features that take the structure functions on the entire city space (undertake the radiation of main city center to surrounding areas and offer the service of central function).

A law exists in the land layout around domestic research-oriented universities. The surrounding areas of Tongji University replaced vacant room by pulling with government, which was launched into a science, technology and economic park and formed a street called Tongji Design Block in Chifeng Road. The Chifeng Road promoted the surrounding roads gradually development, formed Tongji knowledge economic circle. The Tsinghua Science and Technology Park is the core of Zhongguancun around Tsinghua University. Many academes get together and form an industry cluster. With a reasonable proportion and high mix land use around universities, incubators in various types of Science and

Technology Park have become scientific and technological achievements, and the high-tech business-growing cradle. The FAR of incubators have risen to 3.0-4.0.

The surrounding areas of universities should be the entitative space inverted by achievements in university research and industrial development carrier. The first specific requirement of the space is low cost – the surrounding of universities need a lot of low-cost space for the growth of small innovative business. The second is space -- universities and the surroundings should have closely spatial connection, also it is good for teachers and students to take part in more actual innovation activities in the case of intensive innovation enterprise. The third is a suitable environment -- the surrounding areas of universities should have a suitable living environment to attract more creative talents than before to resident and carve out enterprise (Fig. 2). Therefore, the reasonable land layout around universities should have the following tips:

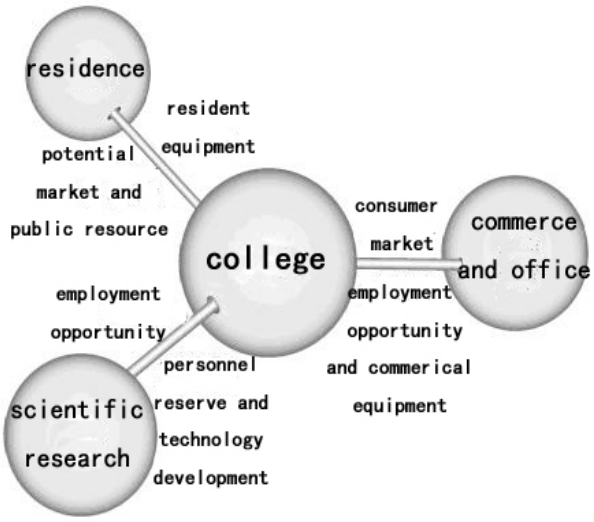


Fig. 2 Relationships among college and other Land

(1) set a suitable ratio to develop researches, residence and commerce;

(2) set up technology parks to provide enough space for enterprises;

(3) promote the connection between technology services and university ascendant subjects;

(4) achieve the universities' function of serving the community and drive the economic even the city's development.

These parks not only focus on technology development, but also pay attention to incubate enterprises. They create an environment for the development of technology products, help and encourage young entrepreneurs to set up the companies.

RESULTS

Reflection of Development Model in the Intensity of Building

Most cities in the world have adopted FAR (floor area ratio) as the main indicator of intensity in development controls. Various cities have different characteristics (Bruce and Rupert 1983; Hafiz 1992; Jean et al. 2004; Tang and Fu 2003). The maximum floor area ratio commonly used to control the population density, which can reduce the population of the external economic benefits. The minimum FAR control can increase the population density or prevent the less development (Joshi and Kono 2009; Matthew et al. 1993). If there are no restrictions on FAR, everyone will gather to the CBD, which causes pollution, traffic congestion and other negative external effects, at last create a single center city (Chu et al. 2004; Rudy et al. 2005; Wang et al. 2006).

The nature of the different sites corresponding to the floor area ratio is often quite different, involving building type, building height, building density and other factors. In general, the FAR of urban core areas is higher than marginal areas. The common situation is industrial < live < commercial, villa < townhouse < multi-layer < small high-layer < high-layer. Cities with different natures have different FRA. Finance, commerce, trade cities have higher FAR while the political, historic, cultural ones have lower FAR ,which in general will have significantly limitation in building height and develop strength (Li and Wei 1996).

Determine the Reasonable Range of FAR

In the urban planning "decision-making game", the developers pay the most attention to the economic benefits, followed by the brand benefits, social benefits (Xian 2007). However, it is easy to ignore the public's interest. The legal status lacks of controlling detailed planning, the deficiencies of planning and management mechanisms will inevitably result in the deterministic FAR frequently running out of control. The majority studies of deterministic FAR still stay in the summary, description, phases. In addition, the current calculation method is lack of technical rationality. This paper will use the model calculations, shape simulation method to obtain the appropriate FAR, which based on a comprehensive analysis of plots research, and the technical rationality needs improving.It must change the working that judged by intuition and experience or simply apply the scientific theory in other disciplines, deduce to the theory of derivation, return to the methodology changes between "human scale" and sustainable development (Xian 2007). To make sure that FRA is not only determined from the view of an

economic point, but also in line with economic, scientific principles and have a practical operability indicator.

The Calculation Steps of Various Types of Floor Area Ratio

Steps to determine the suitable land FAR of this paper: 1) calculate the EFAR and MFAR'S cross-range interval A (MFARmin, MFARmax); 2) determine the PFAR in research block; 3) get the cross-range interval B (MFARmin, PFAR), C (PFAR, MFARmax) which are the intervals between cross-check Interval A range and policy PMAR floor area ratio. Then determine the interval B is the value range of appropriate FAR, and the interval C can be used as elastic range interval to adjust the FAR. Various types of FAR are defined as follows:

Maximum (or Min) floor area ratio (MFAR): The range of land FAR, which meets the capacity of internal and external environment at the same time. It mainly considers the capacity of internal environment.

Policy floor area ratio (PFAR): It is determined by the government which combines experience estimate and comparative analysis with the specific time and space conditions during the establishment process of land policy.

Economic floor area ratio (EFAR): It refers to the ratio when the lowest economic profit you can get (Industry Statutory profit) during the development of certain land use cases (Zhao, et al. 2005).

MFAR is enslaved to environmental capacity, while the EFAR is pursuing economic efficiency. The former range interval is less than the latter. While the PFAR is often in the value domain, Fig. 3 shows the value relationships among the MFAR, EFAR and PFAR. The value in the three cross-range interval is the suitable FAR.

Calculate the Economic FAR

This paper has selected No. 8 Lot in Shenhua Road, Hangzhou West Lake District (now is Wendingyuan Community), as the research object. The Economic FAR which was based on input-output analysis can be used to evaluate the potential of urban land. It could visually reaction the influence of FAR that affected on land value. The first step is to analyze and calculate the EFAR (Xian 2007):

$$F=\frac{P_1S(1+r)^n(1+m)(1+R)}{XS-S(P_2+P_3)(1+r)^{n/2}(1+m)(1+R)} \quad (1)$$

F is economic floor area ratio. P1 is the land transfer price (RMB per m2). P2 is construction settlement allowance (RMB per m2). P3 is land of municipal public infrastructure supporting fee (RMB per m2). X is the housing price with different purposes (RMB per m2), mainly including the purposes of residential, commercial, scientific. S is the status quo Parcel Area (RMB per m2). r for the interest rate (%). m for unforeseen expenses (%). R is the industry statutory profit rate (%). N is the development cycle (years) (Tables 3-5).

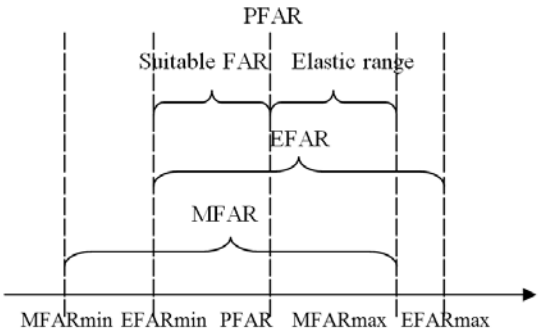


Fig. 3 The relationship among several kinds of FAR

The land transfer price (P1) is set at 7,000 per m2, referred to Shenhua Road, Xihu District. Construction settlement allowance (P2) and the land municipal public infrastructure supporting fees (P3) are according to the nature of land use, development type of land use. X is determined by the current market price. Take 6% as the value of r, take 10 percent as the unforeseen costs, and take 3 as the development cycle years (n). The average selling net profit was 19.6% in estate industry in 2005. Having taken the characteristics of estate industry in Hangzhou and the leap forward tendency in whole Country's estate industry into consideration, 30% is set as the value of R the industry statutory profit margin.

Table 3 FAR of the residential block

Item	P_1(yuan/m^2)	P_2(yuan/m^2)	P_3(yuan/m^2)	X(yuan/m^2)	S(yuan/m^2)	r (%)	m (%)	R (%)	N (years)	a_i (%)	F_{1i}
Multi-Layer	7000	1000	150	6000	28600	6	10	30	3	50	2.2
Small High-Layer	7000	1800	150	7500	28600	6	10	30	3	30	2.4
High-Layer	7000	2000	150	8000	28600	6	10	30	3	20	2.1

Notes：i =1, 2, 3; a_i are Stand for the Proportion of Multi-Layer, Small High-Layer and High-Layer.
F1=a1F11+a2F12+a3F13, a1+a2+a3=1 ===> F1 =2.3.

Table 4 FAR of the commercial block

Item	P_1(yua n/m^2)	P_2(yua n/m^2)	P_3(yua n/m^2)	X(yua n/m^2)	S(yua n/m^2)	r (%)	m (%)	R (%)	N (years)	b_i (%)	F_{2i}
Multi-Layer	7000	1100	150	8000	28600	6	10	30	3	50	1.7
Small High-Layer	7000	1800	150	12000	28600	6	10	30	3	30	1.2
High-Layer	7000	2000	150	15000	28600	6	10	30	3	20	0.9

Notes：i =1, 2, 3; b_i are Stand for the Proportion of Multi-Layer, Small High-Layer and High-Layer.
F2=b1F21+b2F22+b3F23. b1+b2+b3=1 ===> F2=1.3.

Table 5 FAR of the research block

Item	P_1(yua n/m^2)	P_2(yua n/m^2)	P_3(yua n/m^2)	X(yua n/m^2)	S(yua n/m^2)	r (%)	m (%)	R (%)	N (years)	c_i (%)	F_{3i}
Multi-Layer	7000	1100	150	3000	28600	6	10	30	3	50	7.8
Small High-Layer	7000	1500	150	4000	28600	6	10	30	3	30	7.8
High-Layer	7000	1800	150	5000	28600	6	10	30	3	20	5.2

Notes：i =1, 2, 3; c_i are Stand for the Proportion of Multi-Layer, Small High-Layer and High-Layer.
F3=c1F31+ c2F32+c3F33, c1+c2+c3 =1 ===> F3=6.8.

After calculating the FAR of three kinds of development and adding the above appropriate model, 5:2:3 is set as the ratio of residential, commercial, research. The study promotes to increase the proportion of scientific research land, which can be adjusted on the actual situation and enhance the adaptability of the model. Then calculate the rate of economic capacity:

EFAR=d1F1+d2F2+d3F3, d1+d2+d3=1, d1:d2:d3 = 5:2:3(d1, d2, d3 for residential, commercial office, R & D area ratio) ===> EFAR(min)=3.4 (lower limit).

The model has three limitations. First, the model neglected the analysis of inner types and proportion in order to simplify the model. This study adopt fixed ratio of building types (Multi-layer: Small high-layer: High-layer is assumed to be 5:3:2) to compensate for the limitation and calculate floor area ratio of different types (viz. F1, F2, F3). Then establish the proportion of land, get EFARmin by calculated. Second, the model regards unilateral construction settlement allowance and unilateral selling price as known conditions, uses static "statutory profit margin" as the calculation parameter. The results may stray from the fact. Third, the calculation only can unreliably calculate the EFARmin and cannot calculate the EFARmax. It is difficult to break up the calculated values to control plots.

Calculate the Margin FAR

The EFARmin calculated above was 3.4. Then using build models using pattern simulation to analyses and calculate the maximum floor area ratio (Fig. 4 and Table 6). As figures show, with the building density, building height increases and the addition of the shops outer buildings along the street, the total construction area is also increasing. The Maximum FAR is 8.2, which appears in program F.

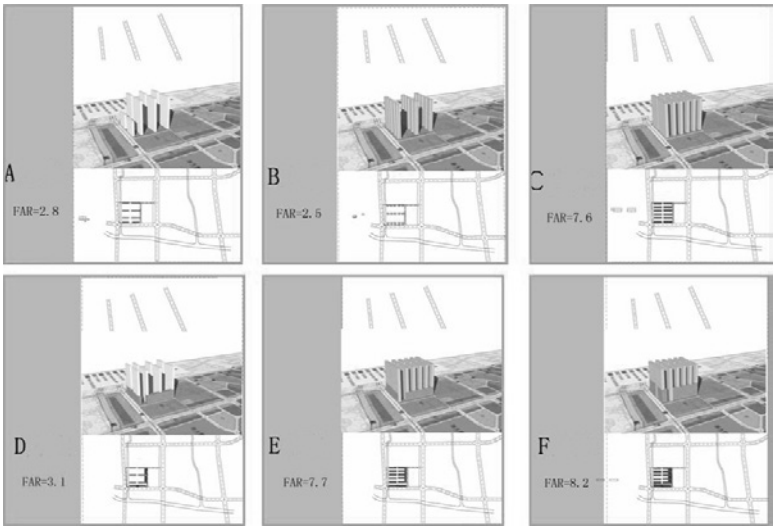
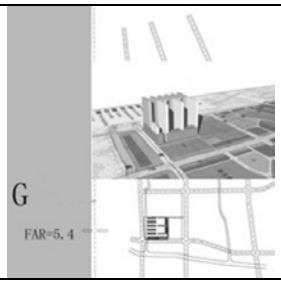


Fig. 4 The case block's design plan comparison

Table 6 A building area comparisons of the studied block's different models

Project A F=2.8	Typical Floor (m^2)	Num. of Floor	Num. of Household	Total Covered Area (m^2)	Project B F=2.5	Typical Floor (m^2)	Num. of Floor	Num. of Household	Total Covered Area (m^2)	Project C F=7.6	Typical Floor (m^2)	Num. of Floor	Num. of Household	Total Covered Area (m^2)
Full Plate Type High-Layer	280 280 3941.6 3720	20 9 4 4	27 8 0.8 0.3	151200 20160 171360 4464 188437.3	Full Dot Mode High-layer	506.30	20 0	15 0	151890 0 151890 463794.6	All High-Layer Office	1800 2000	20 20	6 6	216000 240000 456000 494909.3
Project D F=3.1	Typical Floor (m^2)	Num. of Floor	Num. of Household	Total Covered Area (m^2)	Project E F=7.1	Typical Floor (m^2)	Num. of Floor	Num. of Household	Total Covered Area (m^2)	Project F F=8.2	Typical Floor (m^2)	Num. of Floor	Num. of Household	Total Covered Area (m^2)
Commerce + Habitation	280 280 3941.6 3720	20 9 4 4	27 8 0.8 0.3	151200 20160 12613.3 4464 188437.3	Commerce + Office	1800 2000 3941.6 3720	20 20 4 4	6 6 0.4 0.1	216000 240000 6306.6 1488 463794.6	Large Commerce + Office	1800 2000 5833.9 7135.9	20 20 6 6	6 6 0.5 0.5	216000 240000 17501.8 21407.6 494909.3

Table 7 The optimum scheme of MFAR

Project G		Typical Floor (m^2)	Num. of Floor	Num. of Household	Total Covered Area (m^2)
	Commerce + Office + Residence	1800 280 280 3941.7 3720	20 20 9 4 4	6 15 4 0.8 0.3	21600 84000 10080 12613.3 4464
			FAR=5.45		

Of course, in real life the basic light spacing, fire protection spacing and all levels of the road width within the environmental capacity considered. After comprehensive considerate of these factors, this paper amends the shape simulation program and works out the MFAR's calculation program – G program (Table 7), in which the combination of commercial, office, residential is 66%, 28.7%, 5.3%, and the MFARmax is 5.45.

Set the Appropriate FAR

Through this quantitative analysis, it can be worked out that the EFARmin is 3.4 and the MFARmax is 5.45. PFAR formulation is a complex process. This study does not conduct a detailed study. In accordance with the controlling detailed planning and current status quo, the study set PFAR as 3.6. Therefore, the researched land's suitable values for floor area ratio are (3.4, 3.6), flexible range is (3.6, 5.45). The land is currently developed as residential, after completion, the value of FAR is 2.5. The development of the nearby commune in Cambridge is more comprehensive, including business, scientific office, residential, with its FRA value of 3.5. The appropriate FAR that this paper measured approaches to Cambridge commune. In addition, the study also promoted integrated development in the land use.

Of course, the ratio of the land development is not fixed. The government policies are relate to the development of the block around the research universities. Through the access to those policies and using the same method to Calculate the different land's FAR, this paper suggested some prosper FAR values for land development. And they have different nature and functions (Table 8), such as second-class living land's suitable FAR can be 2.5, commercial, office, hotel-style apartment blocks' suitable FAR can be 3.5, mixed of commercial office and residential land's floor area ratio can be 3, research land's floor area ratio can be 4.2.

Table 8 Suggested values for the block's FAR

Item	Land Usage	Classification Code for Usage of Municipal Terra	Parcel Area (ha)	Floor Area Ratio	Building Density (%)	Building Height Restriction (m)	Greening Rate (%)
1	R2	R2	6.04	2.5	20	60	35
2	Commerce、Office、Apartments	C2、C4、C/R	6.04	3.5	35	60	25
3	Commerce Work、R2	C2、C4、R2	6.04	3	35	45	30
4	Scientific Research Work	C6	6.04	4.2	30	60	20

CONCLUSIONS

An interaction mechanism exists between the suburban campus construction and various surrounding types of land, especially R & D. Universities are driving the surrounding areas when they are also promoted or hampered by these areas. The "gathering - proliferate" and "support - driven" are basic patterns of dynamic relationship between universities and surrounding areas. According to the integration of mathematical model, modality simulation method and related policies, as well as the concept of reasonable floor area ratio, the value of land development intensity around research-originated universities is got. However, the rate is still directly to policies floor area ratio, while the current policy always depends on the experience and determines without scientific rational approach. Research of this paper has a steady proportion about residence, commerce, research and office around research-originated universities. It can provide reference for the rational area distribution and development which around research-originated universities. According to the guidelines of urban master planning and urban detailed plan, the Appropriate Floor Area Ratio (AFAR) calculated and deduced based on Economic Floor Area Ratio (EFAR) and Max/Min Floor Area Ratio (MFAR) can be useful in ratifying land development intensity, predicting future tend and evaluating city planning projects.

ACKNOWLEDGEMENTS

This research is supported by the Natural Science Fund of Zhejiang Province (LQ12E08010), and the humanities and Social Science Fund of the Education Ministry (13YJCZH150).

REFERENCES

Allison B. and David A. W. (2008). Universities and regional economic development: The entrepreneurial University of Waterloo. Research Policy, 37(8): 1175-1187.

André S. (2000). Land readjustment and metropolitan growth: an examination of suburban land development and urban sprawl in the Tokyo metropolitan area. Progress in Planning, 53(4): 217-330.

Bo S. T. and Chung Y. Y. (2010). Space and scale: A study of development intensity and housing price in Hong Kong. Landscape and Urban Planning, 96(3): 172-182.

Bruce K. F. and Rupert F. (1983). Ecological performance standards for land development. Biological Conservation, 26(3): 193-213.

Carol A. P. (2010). New housing construction in Phoenix: Evidence of "new suburbanism"? Cities, 27(2): 77-86.

Chu C. L., Chao C. M. and Ping W. (2004). Urban land policy and housing in an endogenously growing monocentric city. Regional Science and Urban Economics, (34): 241-261.

Ferguson B. K. and Friday R. (1983). Ecological performance standards for land development. Biological Conservation, (26): 193-213.

Hafiz A. P. (1992). The case for heterogeneity of cities. Journal of Urban Economics, 32(3): 318-325.

Harold A. L. A. (1970). University for the postindustrial society. Technological Forecasting, (1): 263-281.

Irwin F. (1990). Universities as engines of R&D-based economic growth: They think they can. Research Policy, 19(4): 335-348.

Jan Y. and Philip S. (2008). Building an innovation hub: A case study of the transformation of university roles in regional technological and economic development. Research Policy, 37(8): 1188-1204.

Jana S. and Luděk Š. (2010). Uncoordinated new retail development and its impact on land use and soils: A pilot study on the urban fringe of Prague, Czech Republic. Landscape and Urban Planning, 94(2): 141-148.

Jean C., Dominique P., Evangelos S. and Jacques F. T. (2004). The periurban city: why to live between the

suburbs and the countryside. Regional Science and Urban Economics, 34(6): 681-703.

Joshi K. K. and Kono T. (2009). Optimization of floor area ratio regulation in a growing city. Regional Science and Urban Economics, (39): 502–511.

Li Z. and Wei C. X. (1996). Five issues about floor area ratio. Urban and Rural Development, (2): 21-13.

Matthew A. N., Allen G. N. and Frank J. C. (1993). Floor area ratio as an urban development tool: The case of West Palm Beach. Land Use Policy, 10(2):127-139.

Phelps N. A. (2010). Suburbs for nations? Some interdisciplinary connections on the suburban economy. Cities, (27): 68-76.

Qiu F. Y. and Zhao F. H. (2006). Explanations about "university serves the society" by presidents of foreign colleges. Science and Technology Daily, 2006-9-7.

Rudy V. D., Frans J. S., Dirk S. and Jan V. D. B. (2005). Relating land-use intensity and biodiversity at the regional scale. Basic and Applied Ecology, 6(2):145-159.

Samsura D. A. A., Krabben E. and Deemen A. M. A. (2010). A game theory approach to the analysis of land and property development processes. Land Use Policy, (27): 564-578.

Sun Z. G. (2000). Theory of urban functions. Economic Management Publishing Company, Beijing, China: 52-59. (in Chinese).

Tang Z. L. and Fu L. (2003). A rational approach to urban density zoning: the case of Shenzhen special economic zone. Urban Planning Forum, (04):1-9.

Wang W. M., Hugues R. and Radu Z. (2006). Floor shape optimization for green building design. Advanced Engineering Informatics, 20(4): 363-378.

Xian B. L. (2007). Study on methods of determination of floor area ratio in urban planning. Xian Architecture and Technology University, Xian, China.

Yang J. J., Lian C. and Tang Y. (2006). Plan research on research-based university and its peripheral locality. Journal of Zhejiang University (Science Edition), 33(3): 338-345.

Zhao K. T., Hu K., Wang D. Y., Li S. J. and Zhang S. J. (2005). Economic floor area ratio in evaluation of utilization potential of urban land. Scientific and Technological Management of Land and Resources, (3): 18-20.

Zheng S. Q. and Matthew E. K. (2008). Land and residential property markets in a booming economy: New evidence from Beijing. Journal of Urban Economics, 63(2): 743-757.

Zhu Q. (2010). Without zoning: Urban development and land use controls in Houston. Cities, 27(1): 31-41.