An evidence-based planning support methodology for site selection of green apartments concerning preferences of various social groups in the Chinese context

Abstract

In the transition from a state-led industrial to a market-driven post-industrial urban economy, Chinese planners are increasingly faced with the challenge to develop sustainable cities. The concept of green building is part of the planning strategy. However, the consumer market has shown limited response to such policies. The knowledge about the willingness of different socio-economic groups to pay for green versus conventional housing attributes need to be integrated in the sustainable planning process. This article proposes an evidence-based planning support methodology to select sites for green apartment construction. It collects, analyzes, and integrates housing preferences of three social groups in planning making. It illustrates the methodology in two scenarios in Nanjing, China: after new metro construction and after redevelopment of heavy industrial areas. Results show that this methodology can help planners and policy makers to select proper sites of green apartments for each social group.

Key words

Evidence-based, planning support methodology, what if analysis, green apartments, social groups

1 Introduction

In the transition from a state-led industrial to a market-driven post-industrial urban economy, high quality of life is desired by the rapidly increasing and wealthier urban population in China. Current master plans have proclaimed planning objectives such as eco-city, smart city, healthy city, and so on. The on-going debate is about the type of city that not only suits the needs of Chinese citizens, but also meets the goals of sustainability. So-called green apartments contribute to the achievement of sustainability (Holden & Norland, 2005). The Chinese government has adopted the green building policy as part of its national strategy to build more sustainable cities. It provides financial incentives such as subsidies to promote the construction of green apartments. However, the building codes in China mainly stress savings in energy consumption (energy performance). The consumer market has shown limited response to such policies, partly due to the fact that government subsidies cover only a part of the extra costs of green apartments.

With changes arising from the transition, the urban housing market in China has become more differentiated. This is evidenced by the emerging pattern of house prices, attracting different socio-economic groups who can only afford homes in a certain segment of the housing market. The extreme hikes in price deny poor people the opportunity to enjoy a living standard similar to that enjoyed by the rich (Vallance et al., 2011). Though the current sustainability policies try to promote green apartments via raising the environmental awareness among developers and consumers, consumers lack demands and are with a

shortage of purchase power for green apartments. If consumers are not willing to pay extra for green apartments, developers will not produce it (Mutter & Sterk, 2012). The promotion for green apartments is then blocked in planning practice.

Current master planning in China mainly makes use of information sources such as statistics, surveys, planning experiences, and planners' professional knowledge. However, these broad sources have not formed a clear role in understanding the housing preferences of various social groups. With these sources, planners might not clearly know the needs of residents. It is argued that different stakeholders have difficulties to understand each other as their various goals and interests give rise to different interpretations and expectations of space (Lefèbvre, 1991). The inability to understand residents burdens planners and policy makers to make planning fitting the needs of residents, particularly the green housing needs of various social groups.

To mainstream green building, planners need to understand the consumer market and the trade-offs homebuyers make with regard to green apartment attributes against other attributes such as accessibility and neighbourhood quality. This knowledge provides planners and policy makers with insights into value system of different social groups about the quality of life. And it helps planners and policy makers to decide the sites of green apartments concerning preferences of various social groups. Planners and policy makers are not aware of this kind of knowledge and they miss the planning methodology to gain the knowledge. Current planning support systems in China mainly use spatial information such as land use and transportation data based on the Geographic Information System (GIS) (e.g. Yeh, 2008; Wang & Zou, 2010). The analyses and simulations in these PSS hardly incorporate perceptions and valuations of residents. Planners need an easy to use PSS to understand people's perceptions and valuations correctly and to apply this knowledge into planning practice appropriately.

In the West, the paradigm of urban planning has shifted from the technology-dependent (the 1960s to 1970s) to a more participatory approach (Douglass & Friedman, 1998). Decision making is no longer mainly based on computer models (routine management tasks) but more on consultations and negotiations with different stake holders (Yeh, 2008). Planning is trying to analyse citizens' perceptions and incorporate their preferences into planning and policy making (Pakir et al., 2012). Nevertheless, the incorporation of people's perception has its difficulties in the planning process. It is pointed out that there is a gap in bringing such knowledge from evidence into planning and decision making due to lack of a useful methodology (Krizek et al., 2009; Biermann, 2011).

In many cases, planning support systems (PSS) and planning support methodologies have been developed to support the integration of people's preferences (Geertman & Stillwell, 2009; van Delden & Hagen-Zanker, 2009). Generally speaking, PSS gather, structure, analyze, and communicate information in planning process by integrating functions such as geographic information systems (GIS), planning models, and visualization (Geertman, 2002;Vonk et al., 2005). PSS are tools focusing on supporting planning. The participatory PSS are designed to facilitate stakeholders' involvement in planning process. For instance, van Delden and Hagen-Zanker (2009) invited stakeholders to value different land use scenarios, and they argued that linking qualitative storylines to quantitative modelling can improve the quality of the total scenario to a very large extent. These participatory PSS focus on specific planning issues in certain planning context and are hardly mainstreamed at large scale and in other context. Geertman and Stillwell (2009) pointed out that most PSS are

academic prototypes or ‘one off’ professional applications that cannot be adopted elsewhere. Biermann (2011) illustrated that the failures in mainstreaming PSS were because of the mismatch between structured outputs of traditional planning models and the more unstructured information needs of decision-makers.

The planning outcomes would change based on different urban policies. The PSS with ‘What If?’ analysis can integrate people’s preferences into different planning scenarios. These scenarios are used to anticipate various ‘What If?’ questions and are often used as a tool to generate discussion among stakeholders (An et al., 2005). However, there is no PSS providing a comprehensive view at the city level to understand green preferences of various social groups and to select sites for green construction.

Taken from the Chinese current situation and the West’s planning paradigm, this article proposes an evidence-based planning support methodology in which housing valuations of various social groups are collected, analyzed, and integrated at the beginning of planning process and at the city level. In this article, evidence is seen as a way of justifying the existing knowledge, indicating possible future scenarios, connecting visions, actions and outcomes in the area covered by the plan (Davoudi, 2006; Faludi, 2006). Since the methodology of using evidence in planning depends on the planning context and the purpose of using it (Lord & Hincks, 2010), this article define the research question as:

‘*To what extent can housing valuations of various social groups be incorporated in site selection of green apartments as evidences to support planning in the Chinese context?’*

The next section analyzes the urban planning in the Chinese context. Thereafter, a conceptual framework is proposed, followed by an elaboration of the applications of evidence-based planning methodology in case studies. Finally, the conclusions are drawn.

2 Urban planning in the Chinese context

Urban redevelopment

Since 1978, with a series of reforms initiated by the Chinese government, urban development interests have been aroused (Shin, 2009). During the reforms, urbanization is characterized as massive influx of rural migrants (Fan, 2002). Research has shown that place of employment, housing rent and the availability of housing affect housing choices of migrants (Ma, 2004). A new development is the involvement of the local government in providing housing to migrants for profit in vacant buildings or by constructing new and large housing compounds (Wu, 2002).

Municipalities take the economic reforms and rapid urbanization as opportunities to re-shape the city at larger scale (Liu, 2009). These municipalities divide land uses from mixed-uses into clearer functions (e.g. residential, commercial, and industrial lands). The urban spatial structure has changed mainly because of the marketization of urban land, the shift of industrial land to tertiary use, urban transportation improvement, etc (Ma, 2004). These cities are undergoing a profound land use shift from industrial to commercial as a consequence of post-reform de-industrialization of socialist enterprises (Ma, 2004). Old, deficit-making and polluting urban factories are either closed down or forced to move out to the suburbs (Zhou &

Ma, 2000). The heavy industries exert negative effects in these surrounding areas due to the air pollution (Wang, 2003).

The urban policies also have impacts on the quality of living of various social groups. Many cities have relocated heavily polluting industries to areas where many poor migrants live, and the polluted water and air in these areas have a negative effect on their health. Poverty can create and accelerate the emergence of many environmental problems and at the same time, environmental problems can broaden and deepen the impacts of poverty (Hald, 2009). The houses in which migrants live often lack amenities and are of low quality (Wang, 2003). With urban housing prices skyrocketing, housing affordability has become an issue for middle and low income households. The market value of residential housing varies greatly between different income-groups, about a 400 per cent difference between the richest and poorest 10 per cent of urban households (Man et al., 2011).

Green construction

China accounts for half of all new buildings in the world, and housing space constitutes approximately 80% of the production (Fernández, 2007). In its 11th Five-Year Plan (2006), the Chinese government adopted energy efficiency of buildings as a strategy to reduce energy consumption. However, few green buildings have been constructed so far in practice. To confront this situation, the Ministries of Finance and of Housing and Urban-Rural Development enacted new policies (2012) with financial incentives for developing residential real estate that meets enhanced standards of energy performance. The maximum subsidy is close to 0.5% of the total building costs per square meter. The aim is to make green buildings account for at least 30% of newly built dwellings by 2020. Whether this goal will be achieved, depends on a feasible green policy and substantial consumer demands. As Yau (2012) pointed, 'the states often use legislation or offer subsidies to motivate developers to build green; however, market forces can lead to green housing provision without any state intervention'.

In the construction of green apartments, quality improvements may spur gentrification and the displacement of poor residents (Curran & Hamilton, 2012). At present, green apartment buildings are mainly built in urban areas with a good location in terms of accessibility and neighbourhood quality. The high price of green apartments is a symbol of luxury for the upper-middle class.

Planning practice

China's planning is influenced by various administrative levels. According to Liu and Salzberg (2012) the central government establishes broad national policies and targets and reviews and approves urban master plans for major cities, mega-investment projects, and applications for rural-to-urban land conversion; while the local governments (municipalities) are responsible to make master plans for the local economy and employment, as well as the provision and management of municipal services.

The fast spatial changes at the local level have made it difficult for the central government to guide and control the master plans, since the approval process usually takes many years, by which time it might be already out of date (Liu & Salzberg, 2012). For instance, urbanization has occurred so rapidly that the actual urban population often exceeds the planned population target for the entire time frame of the master plan, usually 20 years (Liu & Salzberg, 2012).

Though the master plans set a 5-year implementation plan to provide for flexibility, it cannot ensure policy makers taking into consideration the long-term interests of urban residents. It is increasingly criticized that short-term economic growth is often given priority over long-term environmental sustainability by the local governments (Wang, 2003).

In theory, the performance of the local governments can not only be supervised by higher level authorities, but also by the local People's Congresses. The members from People's Congresses represent various defined groups of society and are vested with great lawmaking powers. They are supposed to represent the long-term interests of urban residents. The People's Congresses in many cities are increasingly fulfilling a supervisory role by checking the actions of the municipal government against plans; however, they have neither sufficient technical capacity nor sufficient representation from all stakeholders to intervene (Liu & Salzberg, 2012).

Besides, planning making in China often lacks sufficient integration between land use planning and transportation planning (Liu & Salzberg, 2012). The land-use planning is mainly characterised by property-led process in the last decade (Yang & Chang, 2007). The local governments and the market are tangled in planning process. The inflated property price increases the land value, which in turn stimulate local governments plan and lease more lands for property uses (Liu & Salzberg, 2012). Urban planning institutions are often under the pressure of powerful developers or higher administrative authorities to change development plans to make benefits for themselves respectively (Ma, 2004). A rational land-use planning would ideally allow for higher density development near transit nodes, which makes the land market to capture the benefit of reduced travel times. This is not yet generally the case in China, although some cities are beginning to move towards this direction (Liu & Salzberg, 2012). A better approach is needed to assist planners to systematically integrate the two kinds of planning.

Participation of residents in planning

Quite recently, the planning process has increasingly been opened up for inquiry and monitoring of the general public. In the *City and Country Planning Law (2008)*, Chinese government legalized public participation in planning process. However, citizens' participation is usually limited. They are informed via the planning publicity after a plan has been prepared. The voice of citizens in planning is still weak. When looking at Arnstein's ladder about citizen participation, Chinese public participation in planning is in the phrase of top-down informing (Arnstein, 1969). In interviews with planners, many pointed out 'there are no certain tools to help us in understanding and using people's voices; sometimes we did surveys to know the perceptions of residents before making a plan; however, these projects were very specific and at small scale, they were not representative and difficult to be applied for the whole city or other cities'.

Besides, there is also no existing procedure in urban planning for expert witness testimony over issues relating to the public interest. Increased transparency will not only help safeguard the interests of society, but also prevent uncontrolled rent-seeking behaviour that frequently occurs in urban land use and real estate markets with undesirable consequences such as over speculation and wasted resources (Liu & Salzberg, 2012).

Planning support systems in China

In China, as far as we know, there are no operational PSS to help citizen express their perceptions and valuations yet. Some planning management information systems were designed and applied for planners. They are only spatial analysis models. For example, *GeoStar* (based on GIS techniques) integrates spatial information input, map edit, spatial analysis and other models altogether to assist to realize intelligent planning (Xie et al., 2004). *The digital report system of Nanjing* (based on AutoCAD) is constructed for examination and approval of planning (Xu et al., 2006). *GeoUP* combined GeoStar and AutoCAD into one system, realizing data conversion between them (Ye, 2008).

To sum up, in the transition from a state-led to a market-driven society, urban planning is influenced by both market force and government administration. The planning process lacks comprehensive integration of land use and transportation planning, and has loose implementation practice. The voice of residents is hardly integrated into planning process. In the complex context, planning needs to create values for both end-users (residents) and investors (governments and developers) to achieve the long-term sustainable urban development. Planners and policy makers need to understand preferences of residents on quality of life and to be aware of the outcomes of planning intervention. The conceptual framework in the next section will comprise the planning support methodology planners can use to achieve these goals.

3 Conceptual framework

We propose an evidence-based planning support methodology to assist urban planning process. This methodology aims at simulating different planning scenarios and using 'What If' analysis. To be specific, it can integrate residents' preferences into different planning scenarios by using valuation models. Decisions can be made by multiple stakeholders based on the outcomes of various scenarios.

Our conceptual framework can be divided into five parts: defining planning goals, collecting and analyzing basic evidences to create residents' valuation database, simulating planning scenarios, 'What If' analysis, and decision making. This framework takes Chinese planning context into account and can be mainstreamed in many Chinese cities.

The current urban planning in China is influenced by both market force and government administration, and it should meet the residential demands of various social groups. The evidences can be used in this methodology are residents' housing valuations. Therefore, we define the goals in this methodology as integrate residents' preferences into sustainable planning, providing green apartments for various social groups, and site selection of green apartments. These goals guide planners heading towards win-win situation for urban development by creating values for both end-users (various social groups) and investors (governments and developers).

The basic evidences we can collect consist of housing transaction data at individual level, housing stated choices at individual level, demographic characteristics of various social groups, urban land use which can be detailed into the residential blocks, transportation network including public transportation network and road network. To analyze housing valuation of residents, hedonic price models and conjoint models can be adopted. Hedonic price models (HPM) decompose the price into separate components (Goodman, 1978). House price formation is generally explained by indicators from three broad categories: dwelling

attributes, accessibility, and neighbourhood quality. The attributes selected in each category vary according to the local urban context. Conjoint models (CM) or stated preference methods are used to estimate the willingness to pay for a bundle of housing attributes (Wang & Li, 2004). HPM is a revealed preference model indicating how residents purchase houses in reality while CM is a stated preference model indicating how residents subjectively value housing environment. Based on these valuation models, we construct the database of valuations of various social groups, including data of housing preferences, housing affordability, and willingness to pay for green apartments.

The planning scenarios are determined by the local urban development strategies. Usually, these strategies are land use policies or infrastructure improvements which can influence land lease market, housing market, and quality of life of residents.

Next step, 'What If' analysis can be used based on the scenarios and residents' valuation database. The 'What If' analysis can provide planners and policy makers with insights into the interaction between residents' housing value system and urban policy change. These insights help planners and policy makers to compare the pros and cons of different site selection plans.

Given the intervention during planning process by other stakeholders, we suggest that different stakeholders comprise a planning committee to reach a decision (Arentze et al., 2010). It has been argued that 'What If' analysis offers added value in particular in the systems where plan development is an outcome of a group planning process involving planners, the local community, and other possible stakeholders (An et al., 2005). The planning committee fitting the Chinese planning context can be comprised by planners, policy makers, developers, representatives from land bureau, representatives from transportation bureau, and representatives from the local Peoples' Congress.

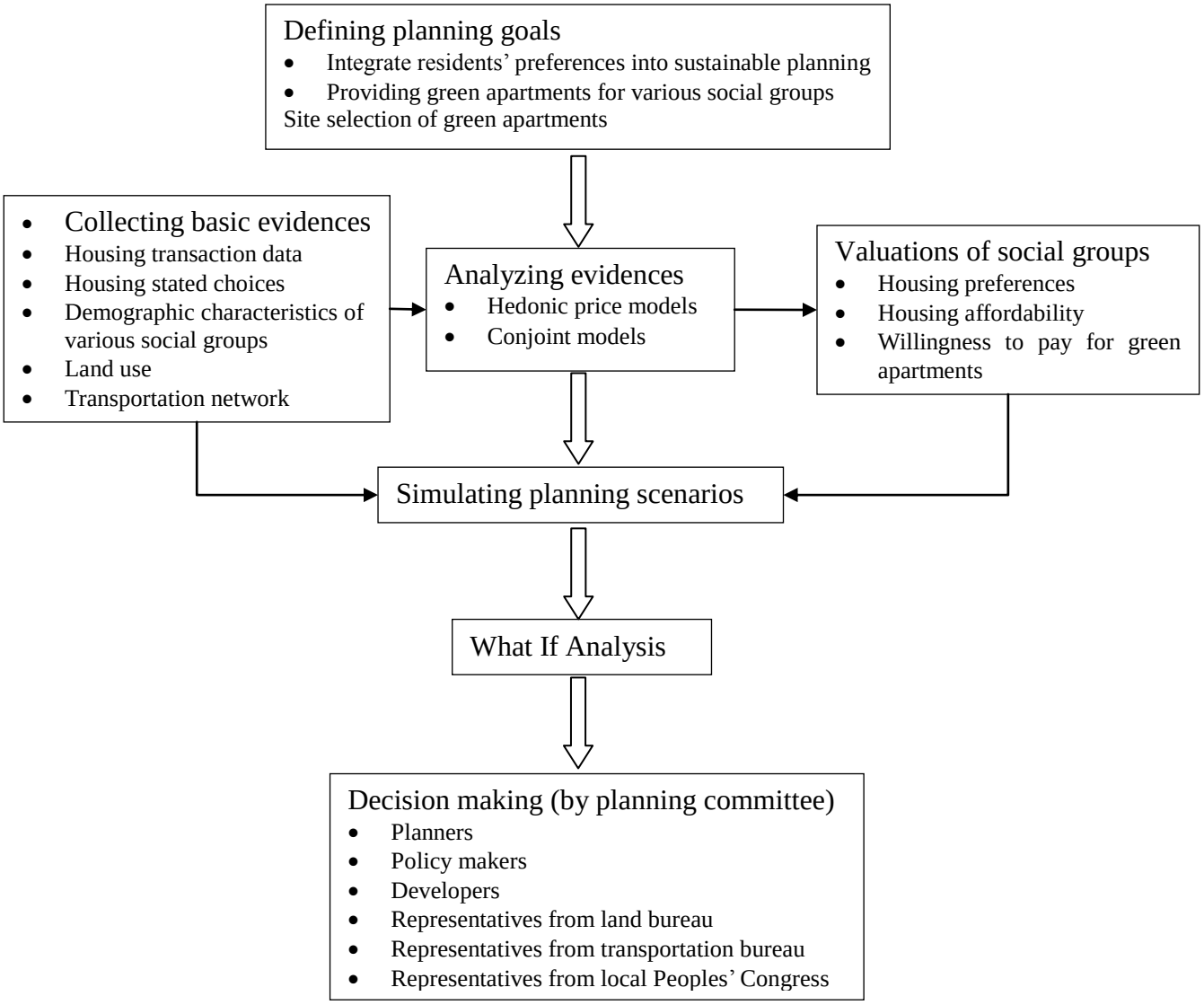


Fig.1 Conceptual framework of evidence-based planning support methodology for site selection of green apartments

4 Case study

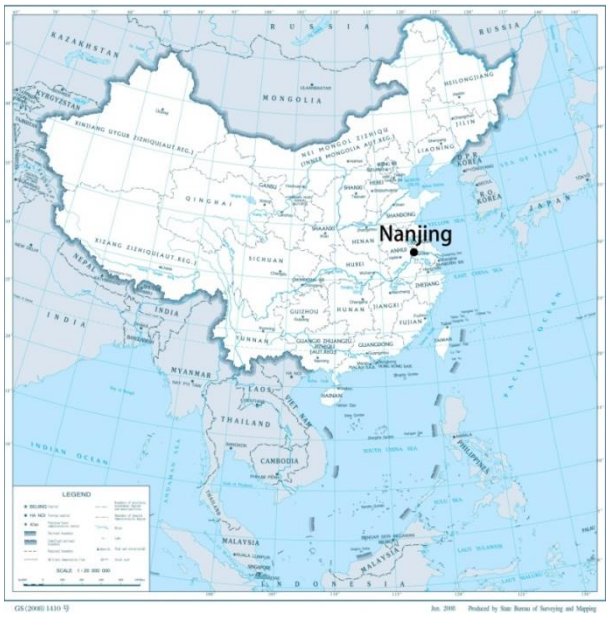
We use the city of Nanjing as the case study area. Nanjing is located in the Yangtze River Delta with the population of 8 million. After 1950, the Nanjing government has invested heavily to build a series of state-owned heavy industries, which converted Nanjing into an important industrial production centre of East China, but also caused serious air-pollution. The heavy industries that occupy large lots are mainly concentrated along the Yangtze River, but smaller ones can be found in nearly half of the neighbourhoods (Figure 2). More recently, the Nanjing government has made great efforts to transform from an industrial production centre to a regional service centre by restructuring old urban districts and creating new urban areas surrounding the city centre. The 12th five year plan of the Nanjing government (2010) indicates that some heavy industries in the southern districts along the Yangtze River will be

relocated to the urban fringe. After the relocation, the brown fields need to be reconstructed to become attractive for new functions.

The Yangtze River splits the built-up area into two parts. The existing two metro lines, which are only located in the south of Yangtze River, are crucial for rapid transportation in the city. Four metros line are under construction to connect the north and south. They will be finished in 2014.

At present, the old urban area has been renewed with the introduction of cleaner land uses such as commercial land and most industries have been relocated to the northern part of the Yangtze River. Land use in the central districts is mainly allocated for commercial, governmental, and residential purposes. There are a few light industries. The southern districts are primarily residential, commercial, and light industrial with some concentration of heavy industrial activities. The northern districts are mainly residential and heavy industrial areas, with several concentrated commercial areas. The three identified areas are differentiated not just in land use but also in other aspects. Since jobs and metro lines are concentrated in the city centre, apartments there have much better accessibility to jobs and public transport as compared to the newly-developed surrounding districts. In the southern districts, accessibility is relatively better than in the northern districts. The city centre has fully fledged services compared to the newly built districts. For instance, good schools are not evenly distributed over the city and the very good schools are located in the city centre only. Air quality varies as well within the city with heavier air pollution in the northern districts. These differences have affected house prices: the average house price in the central districts exceeds the surrounding districts; houses in the southern districts are usually more expensive than those in the northern districts.

The segmentation of housing markets influences the housing choices of the socio-economic groups. An increasing proportion of the lower-middle class live in the northern districts, while the middle and upper-middle classes concentrate in the southern and central districts. As the price of green apartments is high, developers only target the upper-middle class market, and locate green apartment buildings in the newly developed areas near the city centre and in the southern districts. However, the construction of green apartment buildings has been rather limited, which can be explained by the low demand in the present housing market.



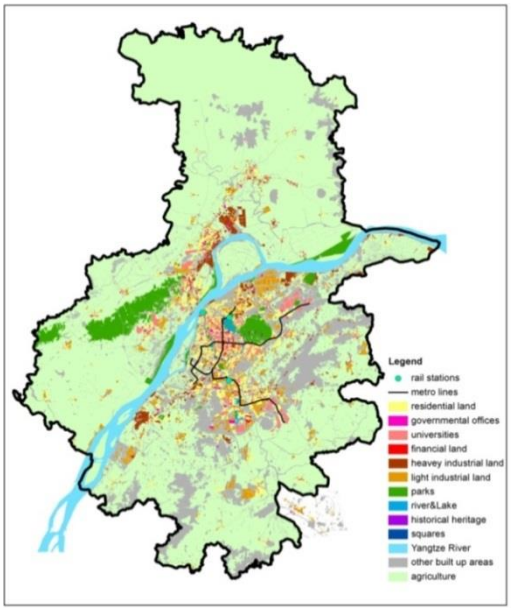


Fig.2 Location and land use map of the study area

We illustrate the evidence-based planning support methodology as follows.

Defining goals

Given the local planning context of Nanjing, we define the goals as:

- analyze green housing valuations of Nanjing people
- select proper sites for green apartment buildings for various social groups

Analyzing evidences and building database

In this section, we use the conjoint model as an example to illustrate our methodology. The conjoint model assumes homebuyers choose an alternative in a choice-set which will provide them with the most benefits or utility. The utility function can be expressed as follows:

$$U_i = \sum \beta_k x_{ik} + \varepsilon_i$$

where β_k is the coefficient of attribute k, x_{ik} is the value of alternative i with respect to attribute k, and ε_i is an error term representing the alternative features that are not specified in the model and variations of taste among respondents; $\beta_k x_{ik}$ is part-worth utility of attribute k to the overall utility of alternative i.

When respondents make a choice, it is assumed that they choose the alternative with the highest utility. Therefore, utility can be linked to the probability that an alternative will be chosen. It is expressed as:

$$P_i = \frac{e^{U_i}}{\sum e^{U_j}}$$

where P_i represents the probability of choosing alternative i, and U_i is the utility of alternative i.

To employ conjoint model in Nanjing, we need to collect data in four categories: spatial information, discrete housing choices, accessibility calculation, and neighbourhood quality (Table 1).

Table 1 Data collection for conjoint models

Data	Description
SPATIAL INFORMATION	
Land use map	--
House price of residential land use	At residential block level
Neighbourhood division map	--
School district map	--
Public transportation map	Bus tops, bus lines, metro stops, metro lines
Urban/Southern/Northern districts division	--
DISCRETE CHOICES	
Choice-sets of housing attributes	Five categories: house price, physical quality of the neighbourhood, social quality of the neighbourhood, accessibility, and green attributes
ACCESSIBILITY CALCULATION	
Access to metro stops	Time cost to nearest metro stop (min)
Job accessibility potential	Accessibility potential score to higher education, large governmental institutions, and financial and business services.

NEIGHBOURHOOD QUALITY	
School quality	--
Environmental pollution	--
Safety from crime	--
Social status of residents	--
Neighbours	--

Spatial information includes land use map at residential block level; neighbourhood division map, school district map, public transportation map with bus lines and metro lines, and urban/southern/northern districts division distinguishing three housing sub-markets.

To investigate homebuyers' willingness to pay for housing attributes in different market segments, respondents were asked to make a choice from a choice-set (Table 2). Thirteen attributes and their values were identified in each submarket. The thirteen attributes can be divided into five categories: house price, physical quality of the neighbourhood, social quality of the neighbourhood, accessibility, and green attributes. The green attributes selected in this article are those key elements that determine the green quality of a house (Rees, 1995; Edwards, 2006; Malmqvist, 2008; Guo et al., 2010). Selected attributes in other categories are those showing the impact on the willingness to pay for a conventional house as identified from the literature (Tse, 2002; Jiao & Liu, 2010; Jim & Chen, 2010; Liu et al., 2010). Based on these housing attributes, 81 choice-sets have been constructed.

The conjoint surveys were conducted from September to December 2011 at 21 real estate sales offices spread across the three market segments in Nanjing. The respondents were potential homebuyers visiting the real estate sales offices at the time. Information regarding respondents' demographic status, affordability, preferences on dwelling attributes (size, number of bedrooms, number of bathrooms, floor level) and hypothetical housing choices were collected. To avoid fatigue and hence unreliable responses, respondents did not receive all 81 choice sets. Rather, we divided the 81 choice-sets into 9 groups with 9 randomly selected choice-sets in each group. Each respondent was asked to make choices within one group only, comprising 9 choice-sets. Respondents had to make a choice from housing in the central, the southern, and the northern districts, or none from each choice-set. A total of 1373 valid surveys were collected, and each choice-set was chosen by 150 or more respondents.

Table 2. An example of a choice-set

	Attribute	A (central districts)	B (southern districts)	C (northern districts)	None of these
House price (6000-30000 yuan/m2)		>30000 yuan/m2	15000-20000 yuan/m2	6000-8000 yuan/m2	
Physical quality of the neighbourhood	School quality (poor-very good)	Very good	Poor	Good	
	Environmental pollution (a lot-no pollution)	Some	No pollution	Some	
Social quality of the neighbourhood	Safety (poor-good)	Average	Average	Average	
	Social status of residents (low-high)	Low	Middle	Middle	
	Neighbours (do not know-friends and family)	Do not know any neighbours	Have some family and friends	Know some neighbours	
Accessibility	Accessibility to metro stop (10-50mins)	10-20mins by public transport	< 10mins by public transport	30-40mins by public transport	
	Accessibility to job (20-40mins)	20-30mins by public transport	20-30mins by public transport	20-30mins by public transport	
Green attributes	Energy and water costs (low-high)	Low	High	High	
	Construction materials (harmful-healthy)	Healthy	Somewhat healthy	Somewhat harmful	

	Thermal insulation (poor-good)	Poor	Good	Poor	
	Sound insulation (poor-good)	Good	Poor	Below average	
	Ventilation (none-good)	Good	Good	Average	
Your choice					

Based on the choices of respondents, we used a conjoint model to estimate the willingness to pay of three social groups (lower-middle, middle, and upper-middle class) in Nanjing for various housing attributes including the green dwelling attributes. Based on the housing valuations, we can select the proper sites for green apartments. The spatial level for site selection is at residential block level. A residential block is the smallest residential land use divided by paths. A neighbourhood consists of several residential blocks.

We need to calculate accessibility, neighbourhood quality, and green house prices for each residential block. To calculate accessibility, we selected access to metro stops and job accessibility potential score. To measure neighbourhood quality, we included variables such as school quality, environmental pollution, safety from crime, social status of residents, having family and friends as neighbours. Since it is very difficult to get the data of safety from crime and social status of residents at neighbourhood level, and of having family and friends as neighbours at household level, we only calculate school quality and environmental pollution in this illustration. In the future, when we have the missing data we can further develop our analysis.

Since affordability play a key role in their housing choices, we need to know the average house price for green apartments in each residential block. The house price will change in the two scenarios respectively, we used hedonic price model to simulate shadow price of house prices of conventional apartments. We then estimated the price of green apartment using the following equation:

$$P\_Ghouse = P\_house + P\_G$$

Where P_Ghouse is the average price of a green apartment in one residential block (yuan/m2), P_house is the average price of a conventional apartment in one residential block (yuan/m2), P-G is the willingness to pay for green attributes, it is different in different sub-markets among different social groups.

Table 3. Willingness to pay for green attributes in different sub-markets among different social groups (yuan/m2)

	Urban central districts	Southern districts	Northern districts
Lower-middle class	0	0	0
Middle class	0	550	450
Upper-middle class	2000	600	0

Defining planning scenarios

We select proper sites according to the willingness to pay of three socio-economic groups: lower-middle class, middle class, and upper middle class. Given urban development circumstance in Nanjing, we define 2 scenarios to illustrate our evidence-based planning methodology.

Scenario 1: new metro network. There are four metro lines under construction which will change the existing metro network of 2 metro lines. This scenario will select proper sites for

green apartment buildings concerning the influences of the new metro network on the accessibility and land price of whole city.

Scenario 2: replacing heavy industrial areas with residential neighbourhood. The Nanjing government plans to move some heavy industries outward. It raises the questions as how to develop the brownfields and how to subsidize heavy industries. This scenario will select proper sites for green apartment buildings concerning the environmental quality change and the land price change of all brown fields and their surrounding residential lands.

What If analysis

We conducted 2 'What If' analyses based on the 2 scenarios above:

- What will be the proper sites of green apartment buildings for different social groups if the four planned metro lines are constructed?
- What will be the proper sites of green apartment buildings for different social groups if the heavy industrial lands are replaced by residential neighbourhood?

1) What If analysis for scenario 1

We evaluated the attractiveness of each residential block for green building construction based on the aggregated score of each block. A score was given to each level of each attribute according to the willingness to pay of residents (Table 4). We knew the average price of a green apartment in one residential block and then we could score it. The school districts could be used to distinguish good schools from average ones. And we marked three very good schools according to interviews with planners. To measure environmental pollution, we used distance to heavy industry. It was found that the heavy industry provided both employment opportunities and nuisances, its negative impact such as pollution and noise takes the leading position at proximate distance, and its positive effect of providing jobs gradually shows up at longer distance. The threshold was a time cots of 20 minutes to heavy industry. Therefore, we gave score 2 to blocks more than 40 minutes away from heavy industry, score 1 to blocks within 20 to 40 minutes to heavy industry, and score 0 to blocks within 20 minutes to heavy industry. Accessibility to job was measured by the aggregated accessibility potential score to higher education, large governmental institutions, and financial and business services. We gave score 2 to blocks with aggregated accessibility potential score above cut-off value of 75%, score 1 to blocks with aggregated accessibility potential score between cut-off value of 50% - 75%, and score 0 to blocks below 50%.

Table 4. Score of housing attributes given by three social classes

Central districts				Southern districts				Northern districts			
Attribute	Score	L	M	U	Attribute	Score	L	M	U	Attribute	Score	L	M	U
Affordability		0	1	1	*Affordability*		2	3	2	*Affordability*		3	2	0
House price (yuan/m2)					*House price (yuan/m2)*					*House price (yuan/m2)*				
20000-25000		2	2	2	10000-15000		2	2	2	6000-8000		2	2	0
25000-30000		1	1	1	15000-20000		1	1	1	8000-10000		1	1	0
>30000		0	0	0	20000-25000		0	0	0	10000-15000		0	0	0
School quality					*School quality*					*School quality*				
Very good		2	2	2	Very good		2	2	2	Very good		2	2	0
Good		2	1	1	Good		1	1	1	Good		2	2	0
Average		2	0	0	Average		0	0	0	Average		2	2	0
Environmental pollution					*Environmental pollution*					*Environmental pollution*				

No pollution	2	2	2	No pollution	2	2	2	No pollution	2	2	0
Some	2	2	1	Some	0	0	1	Some	1	0	0
A lot	2	2	0	A lot	0	0	0	A lot	0	0	0
Accessibility to metro stop				*Accessibility to metro stop*				*Accessibility to metro stop*			
< 1km	0	2	2	< 1km	2	2	2	3-4km	2	2	0
1-2km	1	2	2	1-2km	2	1	2	4-5km	1	2	0
2-3km	2	2	2	2-3km	2	0	2	> 5km	0	2	0
Accessibility to job (by public transport)				*Accessibility to job (by public transport)*				*Accessibility to job (by public transport)*			
< 20 mins	2	1	1	20-30 mins	2	2	2	20-30 mins	2	2	0
20-30 mins	2	1	2	30-40 mins	2	2	1	30-40 mins	1	1	0
30-40 mins	2	0	0	>40 mins	2	2	0	>40 mins	0	0	0
Score L, M, U mean lower-middle, middle, upper-middle class respectively											

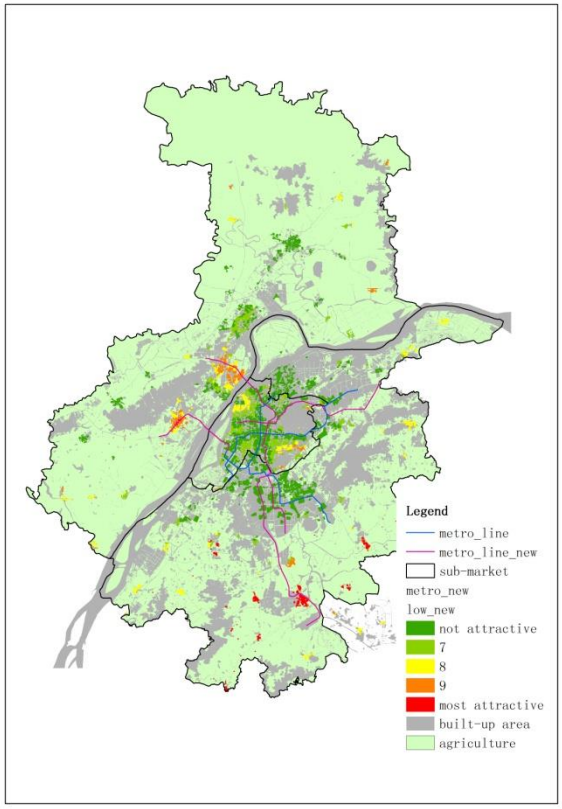


Fig.3 Score of lower-middle class in scenario 1

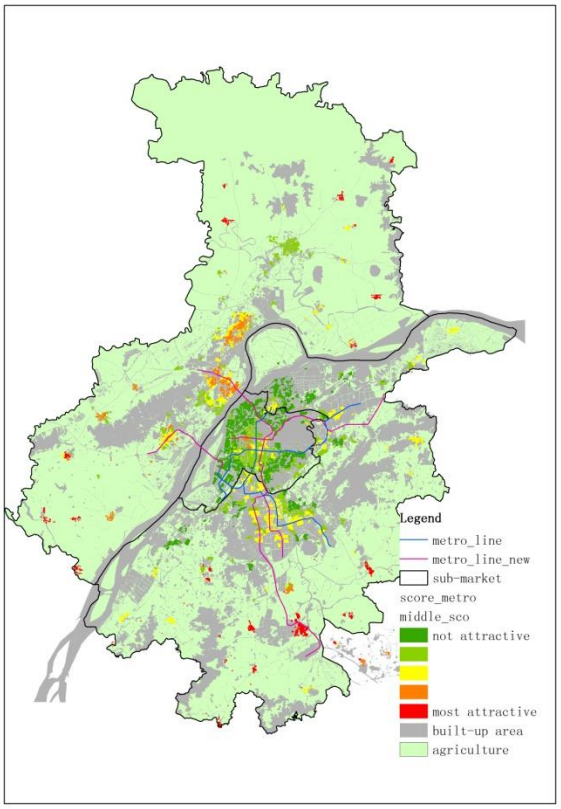


Fig.4 Score of middle class in scenario 1

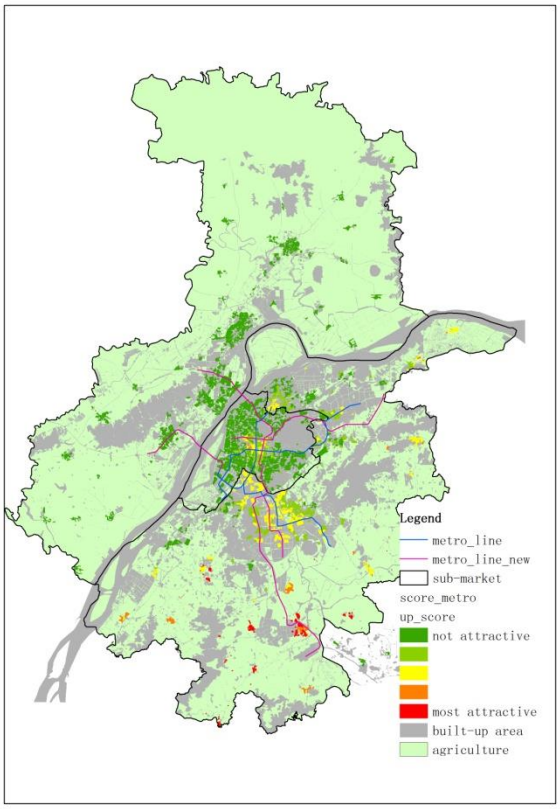


Fig.5 Score of upper-middle class in scenario 1

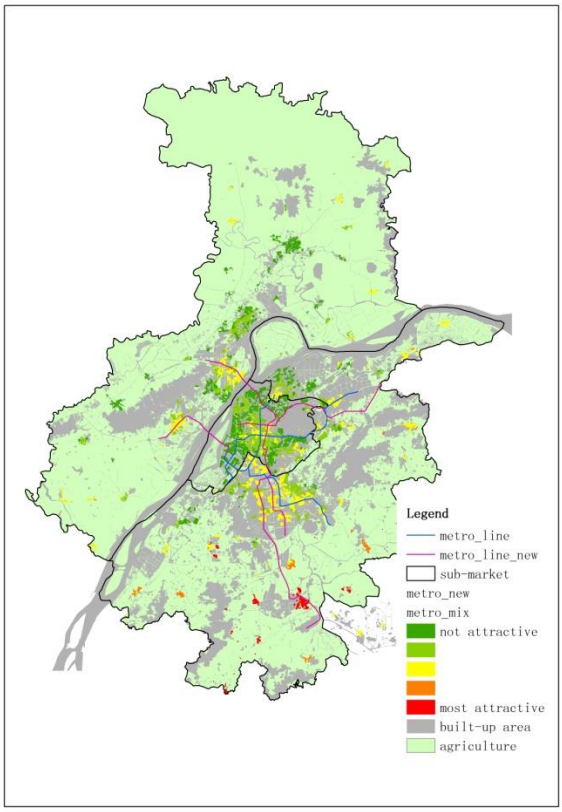


Fig.6 Total score in scenario 1

Figure 3-5 show that people's housing choice is determined by green apartment price, the level of pollution and acceptable accessibility to services and jobs. Relatively clean air as well as acceptable job accessibility is important to the lower-middle class. The new metro lines can improve the accessibility condition of northern districts. Although heavy industries are mainly located in northern districts, green apartments along metro lines in northern districts are attractive to the lower-middle class. They can also buy a really small apartment in the central districts. In the central districts, they care about air pollution and would choose to live areas with low price and less air pollution. In the southern districts, areas far away from city centre with low price are attractive to the lower-middle class, particularly apartments along metro lines with higher score. In contrast, the middle class is willing to pay for much better living conditions in the southern districts. They demand a higher quality of living and are prepared to pay for unpolluted air and easy accessibility. Since they have higher standards of air quality, they would be attracted by areas far away from heavy industry and with relatively lower price and relatively higher accessibility. The upper-middle class prefer to live in the southern districts or in the central districts but not in the northern parts of the city. The areas far away from heavy industry and close to metro lines are most attractive to them.

Figure 6 shows that if Nanjing government plan to build mixed green neighbourhoods for the three social groups, the most attractive areas are in the southern districts. The choices for site selection are slim. These potential areas are far away from city centre and along metro lines.

2) What If analysis for scenario 2

In scenarios 2, these will be no heavy industrial land use in urban areas of Nanjing. Therefore, the environmental pollution of heavy industry should be removed from the score system. We can still adopt the same methodology we used in What If analysis for scenario 1 by excluding the variable of heavy industry.

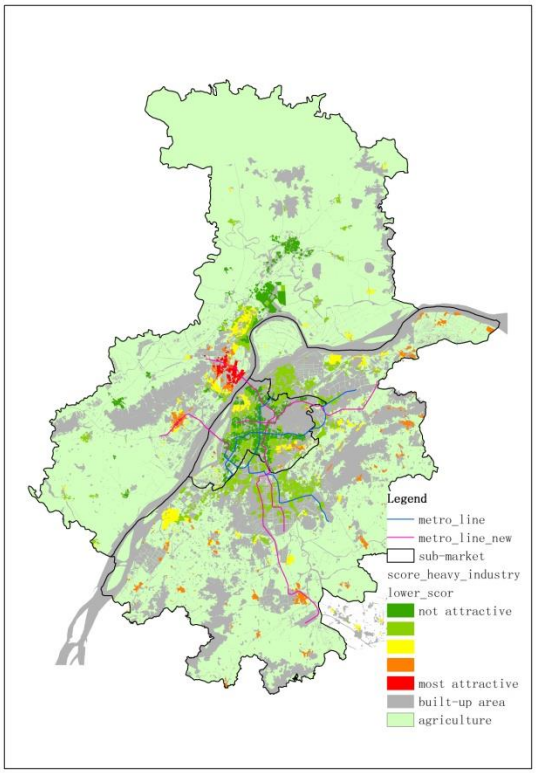


Fig.7 Score of middle-middle class in scenario 2

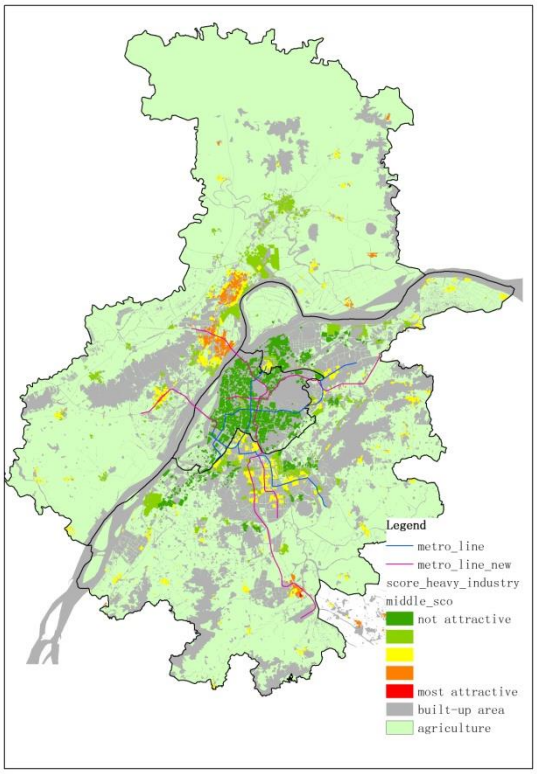


Fig.8 Score of middle class in scenario 2

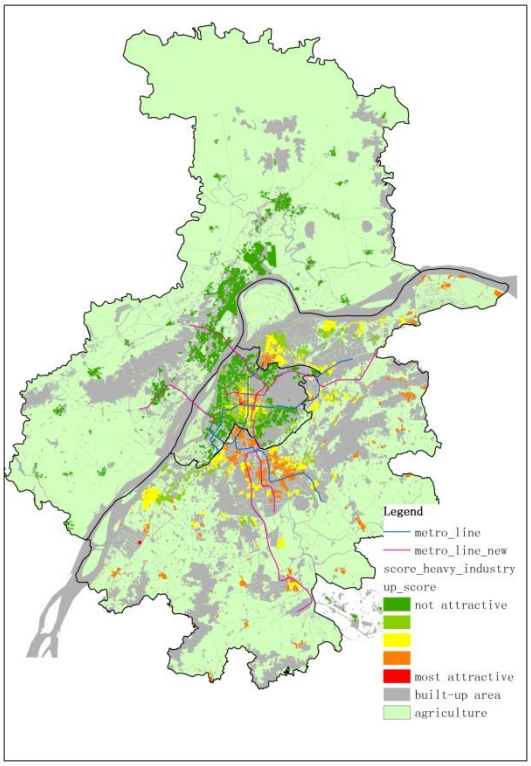


Fig.9 Score of upper-middle class in scenario 2

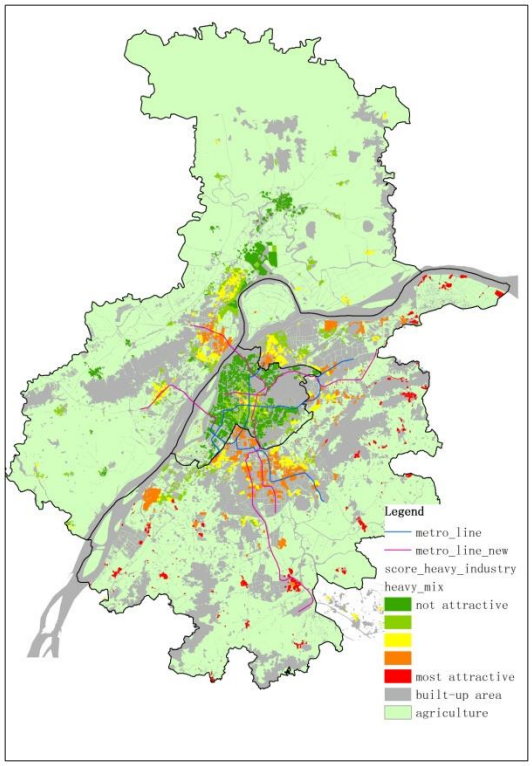


Fig.10 Total score in scenario 2

Figure 7-9 show that after redeveloping heavy industrial areas, there are more potential sites for green apartments. Due to affordable house prices, green apartments along metro lines in northern districts are still the most attractive sites to the lower-middle class. They can also consider some areas in the southern districts. These areas are far away from city centre and are along metro lines. The middle class would live in areas along metro lines in the northern districts and the southern districts. The upper-middle class prefer to live in the southern districts but these areas are close to city centre. Some areas along metro lines in the central districts are also attractive to the upper-middle class. Figure 10 shows that if Nanjing government plan to build mixed green neighbourhoods for the three social groups, the most attractive areas are in the southern districts but close to the city centre.

Decision making

With the What If analysis, the planning committee can understand the potential outcomes of urban policies such as new metro construction and heavy industrial land redevelopment. After negotiation and comparison, they can make a decision about site selection of green apartments to meet the requirements of both end-users (various social groups), planners, policy makers, and developers.

5 Conclusions and discussion

This article proposes an evidence-based planning methodology to response to the challenge faced by Chinese planners of developing sustainable cities. It contributes to integrate people's housing preferences into planning process. By using the evidences such as the valuations of residents, planners and policy makers can better select the sites for green apartments. Since air pollution is everyone's concern, people are very willing to pay to live in an unpolluted neighbourhood. Green apartment buildings are only attractive when they can locate in a good neighbourhood which offers good accessibility.

We proposed our conceptual framework with five parts: defining planning goals, collecting and analyzing basic evidences to create residents' valuation database, simulating planning scenarios, 'What If' analysis, and decision making. Then we applied the conceptual framework in green construction in Nanjing. The results of 2 planning scenarios show the newly constructed metro lines will improve accessibility of northern districts and provide green housing choices for lower-middle class; it will be helpful for mainstreaming green apartments if the present policy of the Nanjing government to redevelop old sites of heavy industry is pushed forward.

Since this methodology is based on general valuation models and Chinese planning context, it can be generalized to other Chinese cities, particularly big cities facing redevelopment problems in transition from industrial to post-industrial society. Given that each city has its local market characteristics, the market division and variable choosing in the valuation models could be changed. For instance, Nanjing is split by the Yangtze River which is a reason of housing market differentiation. Other cities such as Shenzhen which does not have similar geographical characteristics might have different market pattern. Nevertheless, the main principles and measures can be generalized.

References

An, L., Linderman, M., Qi, J., Shortridge, A., & Liu, J. (2005) Exploring complexity in a human-environment system: An agent-based spatial model for multidisciplinary and multiscale integration, *Annals of the Association of American Geographers,* 95(1), pp. 54-79. doi:10.1111/j.1467-8306.2005.00450.x

Arnstein, S. R. (1969) A ladder of citizen participation, *Journal of the American Institute of Planners,* 35(4), pp. 216-224.

Biermann, S. (2011) Planning support systems in a multi-dualistic spatial planning context, *Journal of Urban Technology,* 18(4), pp. 5-37. doi:10.1080/10630732.2011.648432

Curran, W., & Hamilton, T. (2012) Just green enough: Contesting environmental gentrification in greenpoint, brooklyn, *Local Environment,* 17(9), pp. 1027-1042. doi:10.1080/13549839.2012.729569

Davoudi, S. (2006) Evidence-based planning: Rhetoric and reality, *DISP,* 165(2), pp. 14-24.

Douglass, M., & Friedman, J. (1998). *Cities for citizens: Planning and the rise of civil society in a global age* [null]. New York: John Wiley.

Edwards, B. (2006) Benefits of green offices in the UK: Analysis from examples built in the 1990s, *Sustainable Development,* 14(3), pp. 190-204.

Faludi, A. (2006) Guest editorial: Insights into evidence-based planning, *DISP,* 165(2), pp. 3.

Fan, C. C. (2002) The elite, the natives, and the outsiders: Migration and labor market segmentation in urban china, *Annals of the Association of American Geographers,* 92(1), pp. 103-124.

Fernández, J. E. (2007) Resource consumption of new urban construction in china, *Journal of Industrial Ecology,* 11(2), pp. 99-115.

Geertman, S., & Stillwell, J. (Eds.). (2009). *Planning support systems: Best practice and new methods.* New York: Springer.

Geertman, S. (2002) Participatory planning and GIS: A PSS to bridge the gap, *Environment and Planning B: Planning and Design,* 29(1), pp. 21-35. doi:10.1068/b2760

Goodman, A. C. (1978) Hedonic prices, price indices and housing markets, *Journal of Urban Economics,* 5(4), pp. 471-484.

Guo, H. F., Ge, J., Yue, M., Zhou, X., & Jin, W. (2010) Landscape design method for a green community based on green building design theory, *Journal of Zhejiang University: Science A,* 11(9), pp. 691-700.

Hald, M. (2009) Sustainable urban development and the chinese eco-city, concepts, strategies, policies and assessments, *Fridtjof Nansen Institute,* 2009(5), pp. 1-93.

Holden, E., & Norland, I. T. (2005) Three challenges for the compact city as a sustainable urban form: Household consumption of energy and transport in eight residential areas in the greater oslo region, *Urban Studies,* 42(12), pp. 2145-2166. doi:10.1080/00420980500332064

Jiao, L., & Liu, Y. (2010) Geographic field model based hedonic valuation of urban open spaces in wuhan, china, *Landscape and Urban Planning,* 98(1), pp. 47-55.

Jim, C. Y., & Chen, W. Y. (2010) External effects of neighbourhood parks and landscape elements on high-rise residential value, *Land use Policy,* 27(2), pp. 662-670.

Krizek, K., Forysth, A., & Slotterback, C. S. (2009) Is there a role for evidence-based practice in urban planning and policy? *Planning Theory and Practice,* 10(4), pp. 459-478. doi:10.1080/14649350903417241

Lefèbvre, H. (1991) The production of space. *Oxford: Blackwell,*

Liu, Z., & Salzberg, A. (2012). Chapter 4 developing low-carbon cities in china: Local governance, municipal finance, and land-use Planning—The key underlying drivers. In A. Baeumler, E. Ijjasz-Vasquez & S. Mehndiratta (Eds.), *Sustainable low-carbon city development in china* (pp. 97-127). Washington DC: The World Bank.

Liu, X. (2009) Evolution of transitional institutions for urban land redevelopment in china - case in guangzhou, *Chinese Geographical Science,* 19(1), pp. 1-7. doi:10.1007/s11769-009-0001-8

Liu, Y., Zheng, B., Turkstra, J., & Huang, L. (2010) A hedonic model comparison for residential land value analysis, *International Journal of Applied Earth Observation and Geoinformation,* 12S, pp. S181-S193.

Lord, A., & Hincks, S. (2010) Making plans: The role of evidence in england's reformed spatial planning system, *Planning Practice and Research,* 25(4), pp. 477-496. doi:10.1080/02697459.2010.511019

Ma, L. J. C. (2004) Economic reforms, urban spatial restructuring, and planning in china, *Progress in Planning,* 61(3), pp. 237-260. doi:10.1016/j.progress.2003.10.005

Malmqvist, T. (2008) Environmental rating methods: Selecting indoor environmental quality (IEQ) aspects and indicators, *Building Research and Information,* 36(5), pp. 466-485.

Man, J. Y., Zheng, S., & Ren, R. (2011). Housing policy and housing markets: Trends, patterns, and affordability. In J. Y. Man (Ed.), *China's housing reform and outcomes* (pp. 3-18). Cambridge, Massachusetts: Lincoln Institute of Land Policy.

Mutter, A., & Sterk, L. (2012). Increasing consumer awareness in energy-efficient housing . *Strategic energy solutions – A case study of the öresund region* (pp. 33-38). Lund: International Institute for Industrial Environmental Economics (IIIEE).

Pakir, A. H. K., Tabassi, A. A., Ramli, M., Bakar, A. H. A., & Roufechaei, K. M. (2012) Sustainable housing development and leadership: A review, *Australian Journal of Basic and Applied Sciences,* 6, pp. 385-395.

Rees, W. E. (1995) Achieving sustainability: Reform or transformation? *Journal of Planning Literature,* 9(4), pp. 343-361.

Shin, H. B. (2009) Residential redevelopment and the entrepreneurial local state: The implications of beijing's shifting emphasis on urban redevelopment policies, *Urban Studies,* 46(13), pp. 2815-2839. doi:10.1177/0042098009345540

Tse, R. Y. C. (2002) Estimating neighbourhood effects in house prices: Towards a new hedonic model approach, *Urban Studies,* 39(7), pp. 1165-1180.

Vallance, S., Perkins, H. C., & Dixon, J. E. (2011) What is social sustainability? A clarification of concepts, *Geoforum,* 42(3), pp. 342-348. doi:10.1016/j.geoforum.2011.01.002

van Delden, H., & Hagen-Zanker, A. (2009). New ways of supporting decision making: Linking qualitative storylines with quantitative modelling. In S. Geertman, & J. Stillwell (Eds.), *Planning support systems: Best practice and new methods* (pp. 347-368). New York: Springer.

Vonk, G., Geertman, S., & Schot, P. (2005) Bottlenecks blocking widespread usage of planning support systems, *Environment and Planning A,* 37(5), pp. 909-924. doi:10.1068/a3712

Wang, D., & Li, S. -. (2004) Housing preferences in a transitional housing system: The case of beijing, china, *Environment and Planning A,* 36(1), pp. 69-87. doi:10.1068/a35263

Wang, Y. (2003) Living conditions of migrants in inland chinese cities, *Journal of Comparative Asian Development,* 2(1), pp. 47-69. doi:10.1080/15339114.2003.9678371

Wang, Y., & Zou, Z. (2010) Spatial decision support system for urban planning: Case study of harbin city in china, *Journal of Urban Planning and Development,* 136(2), pp. 147-153. doi:10.1061/(ASCE)0733-9488(2010)136:2(147)

Wu, W. (2002) Migrant housing in urban china: Choices and constraints, *Urban Affairs Review,* 38(1), pp. 90-119. doi:10.1177/107808702401097817

Xie, S., Li, A., Wang, F., & Cui, B. (2004) Application of urban planning management information system based on GeoStar, *Journal of Geomatics,* 29, pp. 3-5.

Xu, J., Qi, Y., Chi, Y., & Wang, F. (2006) The digital report system of planning examination and approval based on the customized design, *Planners,* 22, pp. 57-60.

Yang, Y. -., & Chang, C. -. (2007) An urban regeneration regime in china: A case study of urban redevelopment in shanghai's taipingqiao area, *Urban Studies,* 44(9), pp. 1809-1826. doi:10.1080/00420980701507787

Ye, B. (2008) Improving scientificity of urban planning based on informationization, *Jiangsu Urban Planning*, 5, pp. 33-35.

Yeh, A. G. (2008). *GIS as a planning support system for the planning of harmonious cities*. Nairobi, Kenya: UN-HABITAT.

Zhou, Y., & Ma, L. J. C. (2000) Economic restructuring and suburbanization in china, *Urban Geography*, 21(3), pp. 205-236.