Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 196 (2017) 816 – 821

Procedia Engineering

www.elsevier.com/locate/procedia

Creative Construction Conference 2017, CCC 2017, 19-22 June 2017, Primosten, Croatia

A framework for conservation construction plan model (CCPM)

Anqi WANG[a], Edwin CHAN[a]*, Stanley YEUNG[a]

[a]The Hong Kong Polytechnic University, Hong Hum, Kowloon, Hong Kong, China

Abstract

Land development and construction activities influence adversely on the ecological environment, in most circumstances. However, the growing awareness of sustainable development and peoples' willingness to pay for natural landscapes enable developers to gain rather than lose profit from land conservation activities. Therefore, confronting the conflict of land development and land conservation, it is important to understand the relationships between construction plan and its conservation implications as well as economic benefits. This study proposed a framework of conservation construction plan model (CCPM), and three parts of the model framework were represented. Literatures of landscape features and their relationship with housing prices were reviewed, as the basis of model design. This study contribution to the body of knowledge with a set of factors, related to land use structure, landscape environment, conservation value, residential development characteristics, construction density, housing price, etc. which were identified and considered in the model. It also contribute the CCPM to show construction plan scenarios with different land use structures and patterns and to compare the scenarios with changes in economic and environment values, etc. The model framework would contribute to creative construction plans, as a supporting tool for making scientific decisions, preserving land ecological value and maximizing the integrated utility of land resources.

© 2017 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Peer-review under responsibility of the scientific committee of the Creative Construction Conference 2017

Keywords: Construction Plan; Land Conservation; Housing price; Land use

1. Introduction

Due to the environment pressure on construction works and the increasing requirement for resource efficiency, the concept of sustainable development becomes more and more important in construction industry. The competitiveness

* Corresponding author. Edwin CHAN. Tel.:852-2766 5800.
E-mail address: bsedchan@polyu.edu.hk

1877-7058 © 2017 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the scientific committee of the Creative Construction Conference 2017
doi:10.1016/j.proeng.2017.08.012

in construction market could be remarkably influenced by contribution of sustainable construction practice. [1] However, the costs and benefits lose related to sustainable construction become great barriers to its wide spreading. The question of whether environmental performance in construction could increase or reduce the projects' profitability was fiercely debated in industry and academia. To reach the target of improving in both environmental and economic or financial performance, mechanisms of better access to certain markets, differentiating products, costs adjusting, promoting environment performance and environmental management etc. were pointed out and applied to practice. [2, 3]

The planning and design phases in construction offered the greatest potential for influencing project performance. [4] Construction plan also played a vital role in the improving the environment performance of construction projects, determining the land use layout and land cover distribution of the construction site. Since land cover change from natural land to developed land would adversely affect soil, vegetation, water quality, and other ecological resources [5, 6], the land be preserved for natural conservation and landscaping design has higher environmental or ecological value than developed land. Therefore, to increase conservation land and reduce developed land would be effective to achieve sustainable construction, especially for mega infrastructure projects and large area development. In order to conduct actual implementation, it is important to understand the relationships between land use layout and its environmental implications as well as economic benefits, which should be explained and emphasized, including the higher net profits, increased asset values, etc. [7]

To explore the relationship between land conservation and economic benefits in construction plan, a framework for developing the conservation construction plan model (CCPM) was proposed in this study. Whether peoples' willingness to pay for natural landscapes enables developers to gain rather than lose profit from land conservation activities could be answered with this model. To figure out the relationship between landscape features and housing prices, related literatures were first reviewed. The principles of making different scenarios by adjusting planning factors and evaluating different plans were then introduced. And processes of model running were illustrated with flow charts. The model is proposed to be used not only to theoretically obtain the optimal conservation construction plan, but also to evaluate and compare different construction plan scenarios for practical decision making.

2. Research Methods

2.1. Landscape features and housing prices

Land values were influenced by construction planning factors, such as lot size, landscape feature, density, etc. For example, higher housing values in a subdivision may result from smaller blocks, interconnected greenways, and a single entrance that provides a sense of arrival.[8, 8a] Many researchers also identified the positive effects of nature landscaping on housing price. These landscape features included neighborhood association-owned forest and water, as well as public parks.[9, 10] Relationship between landscape features and housing prices the basis of CCPM, indicating finical benefit of conservation plan as well as its potential market demand. Literatures using hedonic price model to explore the relationship between landscape features and house prices were reviewed, it is suggested that preserved open space, and grass or water views would raise housing price by 5% [11] to 13.2% [12], varied among international cities and cases[13, 14]. This premium value may increase as the distance to the open space shortened. [15, 22] It indicates that although the land for open space could not be sold directly for housing supply, they produce premium value to house nearby through improved living environment.

2.2. Construction planning factors and revenue

A set of factors in construction planning influence the amount of housing supply, which determined the revenue of the construction project. According to "Measures for Formulating City Planning" in China, land use category, site coverage, building height, plot ratio, greening rate, regulations of infrastructure and public service facilities were the compulsory contents in regulatory plan for detailed land development control. Governments and developers could negotiate about land sale conditions and these construction planning factors would be adjusted to reach a consensus. Normally for developers, the more houses were sold, the more revenue would be earned. Therefore, they would strive

for high plot ratio, less site coverage and greening rate, implying more land to be developed. Revenue (REV) is the product of Gross floor area (GFA), Average house sale price per unit area (AHP). See Formula (1).

$$REV = GFA * AHP \quad (1)$$

However, if the landscaping features could be taken into consideration, it may inspire developers to conserve land for open space instead of developing it for houses. Based on literatures in Section 2.1, although sparing land for landscaping would reduce the built-up land area (BLA), it also produced premium value (p) as economic incentives at the same time. See Formula (2), where PR means plot ratio.

$$REV = (BLA * PR) * (AHP + p) \quad (2)$$

In view of the negatively correlation between built-up land area and premium rate, which implies the house sale price may increase as built-up land area decreasing, the Revenue may not be changed with built-up land area. Figure 1 provides an example to show the principle of the conservation plan model. Here, the land was separated into square land cells, related to the raster databases of the construction site map, and properties' values were saved in cells. Two land development scenarios were briefly showed, all land developed and one centered cell conserved. For each cell, it has two indexes of economic index and conservation index. In land use pattern, the grey cell means the land was developed, the conservation index value of which was designated as is 0, while vacant cell means the land was undeveloped and conserved with the conservation index value of 1. Assuming the economic index value of cells sold at AHP is 1, and around conserved land is 1+p.

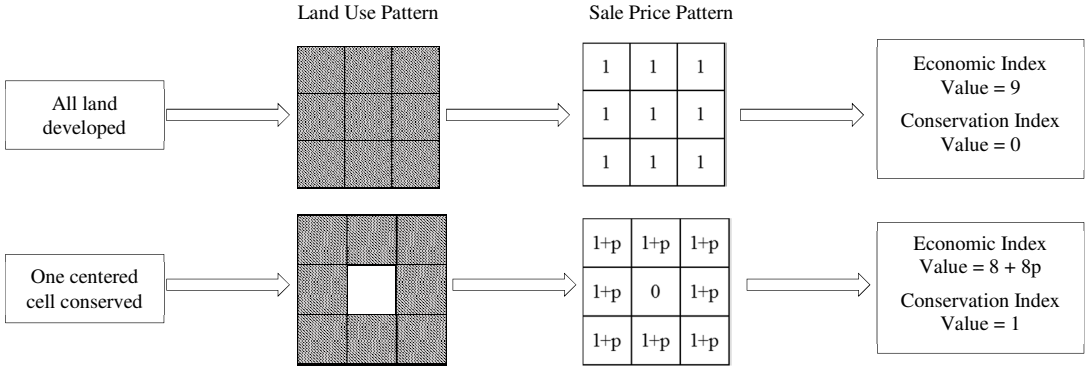

Figure 1. The principle of the conservation plan for scenario simulation and decision making

According to Figure 1, the value of conservation index in second scenario will be definitely higher than it in first scenario when all land cells were developed. However, it is uncertain whether the second scenario could also be advantaged in economic benefit. If 8 + 8p is larger than 9, or p is larger than 0.125, the second scenario would be the better choice regarding both economic and environment aspects. In other words, if the houses conserved greenery could be sold at the price 12.5% higher than average house price, developers would earn same revenue as the all land developed plan. The larger the premium value, the more revenue in second scenario. As mentioned in Section 2.1, the range of premium value from 5% to 13.2%, which may be higher than 12.5, suggesting the possibility of win-win plan in second scenario.

In addition, the price premium values vary spatially are related to other variables such as size, proximity, spatial configuration, and species composition of open space [17, 18, 22]. Better types of open spaces may increase the scope and effect of amenity. For example, urban parks are suggested to be more highly valued than other types of urban open space including forests, agricultural and undeveloped land. [19] It is also found that the premium declines with

distance from the conserved parcel [20], which indicated the surrounding cells which are not next to the conserved land may also positively influence by land amenity, depending on the influence scope of the open space. According to the case study in Tennessee, evaluated at an initial distance of 1km, moving 100m closer to an evergreen woodlot increases the average house price by about 0.6%, while moving 100m closer to a deciduous forest patch decreases the average house price by 0.5% approximately [17]. Due to the uncertainty of price premium value, a survey to the potential house buyers of the construction projects is required, in order to find out their capacity and willingness to pay for the natural views and better living environment before making construction plan. Data of the price premium, needed in one input layer of the proposed model, could be collected from this survey.

2.3. The framework of CCPM

The conservation construction plan model (CCPM) aims to find out the plan scenario of high environment conservation value, providing pieces of green spaces without compromising the revenue from the construction project. The three properties of each land cells are economic value, price premium, and conservation value, obtaining the data value from three layers of land use pattern, price premium, and conservation value, respectively. The process of making conservation construction plan was illustrated in the left flow chart of Figure 2.

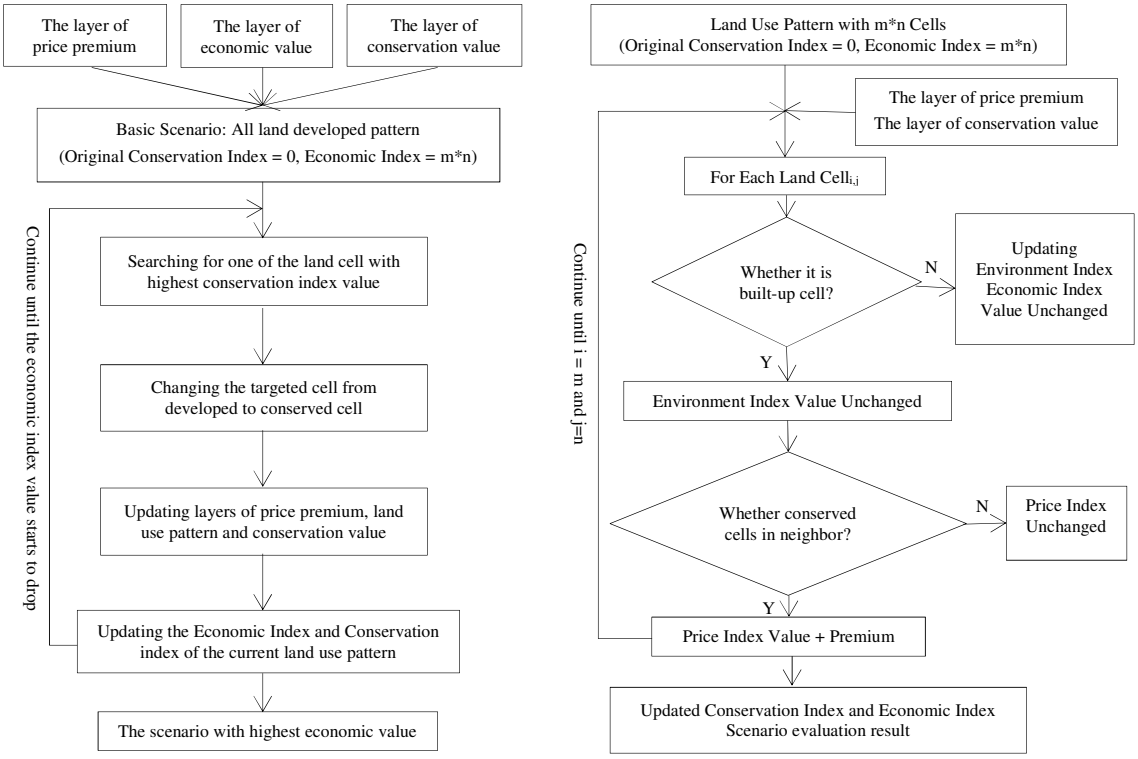

Figure 2. The flow chart of making conservation construction plan (left) and the flow chart of scenario evaluation with two indexes (right)

Based on the input of three layers, the model was run started from the basic scenario, assuming all land cells were developed for buildings. Afterwards, one of the land cell with highest conservation index value was targeted to be preserved, and its property of utilization changed from development to conservation, and its property of conservation value change to 1 or other designated number. Simultaneously, the price premium of cells in neighbor changed corresponding to designed rules. These steps of searching for targeted cells and updating the properties, and calculating the economic and conservation indexes would continue, until the economic index value starts to drop, which implies that if one more land cell was conserved for unbuilt-up purpose, the price premium of green space would not balance

the loose of reduced land supply, and the revenue would decrease. Therefore, the plan scenario with highest economic value was made.

The framework of making CCPM is a useful tool for government, planners and developers to understanding the potentiality of conserving more ecological land and provide more open spaces in construction project. However, in real world, optimal conservation construction plan is difficult to be achieved, since conducting construction projects is a completed process. To imply the CCPM in supporting planning decision making, it could as be a tool of evaluating feasible planning scenarios proposed by developers. Referring to the right flow chart in Figure 2, the values of conservation index and economic index of proposed scenarios could be calculated. The evaluation results would help to figure out of the advantaged scenarios among different plans, regarding there conservation and economic values.

3. Discussion

In construction planning, the proposed CCPM is useful to balance the environment influence and economic benefits of construction project. The most difficult part for its implantation is to figure out the quantitative relations between the design or construction features and the price premium brought by the landscaping features. It is identified the uncertainty in the outcome of new designs and the cost of credit are the barriers for the widespread adoption of ecological subdivision designs [21]. Although positive effect of land conservation to land price were proved in many research, it may not always be positive in all cases. Referring to a review study, the significant amenity effects of open space, forest and wetland were reported in about half of the observations, and effects of preserve and diversity amenities were more widely found in 9 out of 11 and 6 out of 8 observations.[10] Since the data of price premium is one of the important input layers in the model, it should be carefully verified before conducting the model in real case study. Additionally, when more design features and construction factors were involved, the economic analysis would be more complicated. For example, reduction in lot size to preserve open-space and utilization of a swale-based drainage system would both result in a lower sale price per lot, which meanwhile would also result in the lowest per lot construction cost. [23] When leading to the complex analysis, however, other influential factors of lot size, plot ratio, drainage system, etc., also indicate directions to improve the CCPM and maximize project revenue.

4. Conclusion

The conservation plan is an effective approach of preserving more natural land in construction project, but the uncertainty of economic benefit became the barrier for it implementation. According to the reviewed literatures, the positive influence of landscaping amenities on housing price were observed in most conditions, with price premium from 5% to 13.2% to the housing price. This indicated that sparing land for landscaping could be the economic incentives to increase the revenue and reduce the built-up land area at the same time. Based on this principle, the framework for conservation construction plan model (CCPM) was demonstrated. Indexes of Economic Value and Conservation Value were used to assess different plan scenarios. Processes of making conservation construction plan and evaluating scenarios were showed in flow charts. This study contribution to the body of knowledge with a set of factors, related to land use structure, landscape environment, conservation value, residential development characteristics, construction density, housing price, etc. which were identified and considered in the model. It also introduces the CCPM to show construction plan scenarios with different land use structures and patterns and to compare the scenarios with changes in economic and environment values, etc. The model framework would enhance creative construction plans with increasing the environmental value and preserving more land without compromising the economic benefits. The proposed model could be used as a supporting tool for decision making in construction plans, which would help governments, planners as well as developers to maximize revenue and the integrated utility of land resources.

Acknowledgements

The research is funded by Hong Kong Research Grant Council and The Hong Kong Polytechnic University (Project A/C 1-BBA6 and 1-ZVEV).

References

[1] Y.T. Tan, L.Y. Shen, H. Yao, Sustainable construction practice and contractors' competitiveness: A preliminary study, Habitat Int., 35 (2011) 225-230.
[2] S. Schaltegger, T. Synnestvedt, The link between 'green' and economic success: environmental management as the crucial trigger between environmental and economic performance, Journal of Environmental Management, 65 (2002) 339-346.
[3] S. Ambec, P. Lanoie, Does It Pay to Be Green? A Systematic Overview, Acad. Manag. Perspect., 23 (2008) 45-62.
[4] R. Valdes-Vasquez, L.E. Klotz, Social Sustainability Considerations during Planning and Design: Framework of Processes for Construction Projects, J. Constr. Eng. Manage.-ASCE, 139 (2013) 80-89.
[5] J. Xiao, Y.F. Wang, P. Shi, L. Yang, L.D. Chen, Potential effects of large linear pipeline construction on soil and vegetation in ecologically fragile regions, Environmental Monitoring and Assessment, 186 (2014) 8037-8048.
[6] N. Musaoglu, A. Tanik, V. Kocabas, Identification of land-cover changes through image processing and associated impacts on water reservoir conditions, Environmental Management, 35 (2005) 220-230.
[7] S. Aiello, Addressing Finacial Objections to Sustinable Design and Construction, Journal of Green Building, 5 (2010) 67-77.
[8] W.J. Shin, J. Saginor, S. Van Zandt, Evaluating Subdivision Characteristics on Single-Family Housing Value Using Hierarchical Linear Modelling, J. Real Estate Res., 33 (2011) 317-348.
[8a] Chan E H W, Yiu C Y, Baldwin A N, Lee G KL (2009) Value of Buildings with Design Features for Healthy Living ¨C A Contingent Valuation Approach, Facilities, Vol 27 (5/6), 229-249.
[9] T. Bowman, J. Thompson, J. Tyndall, Resident, developer, and city staff perceptions of LID and CSD subdivision design approaches, Landscape and Urban Planning, 107 (2012) 43-54.
[10] F. Waltert, F. Schlapfer, Landscape amenities and local development A review of migration, regional economic and hedonic pricing studies, Ecological Economics, 70 (2010) 141-152.
[11] D. Earnhart, Using contingent-pricing space and its duration analysis to value open at residential locations, Land Economics, 82 (2006) 17-35.
[12] C.Y. Jim, W.Y. Chen, Impacts of urban environmental elements on residential housing prices in Guangzhou (China), Landscape and Urban Planning, 78 (2006) 422-434.
[13] C.Y. Jim, W.Y. Chen, Consumption preferences and environmental externalities: A hedonic analysis of the housing market in Guangzhou, Geoforum, 38 (2007) 414-431.
[14] H.A. Sander, S. Polasky, The value of views and open space: Estimates from a hedonic pricing model for Ramsey County, Minnesota, USA, Land Use Policy, 26 (2009) 837-845.
[15] C. Ham, P.A. Champ, J.B. Loomis, R.M. Reich, Accounting for Heterogeneity of Public Lands in Hedonic Property Models, Land Economics, 88 (2012) 444-456.
[16] P.K. Asabere, The Value of Homes in Cluster Development Residential Districts: The Relative Significance of the Permanent Open Spaces Associated with Clusters, J. Real Estate Financ. Econ., 48 (2014) 244-255.
[17] S.H. Cho, N.C. Poudyal, R.K. Roberts, Spatial analysis of the amenity value of green open space, Ecological Economics, 66 (2008) 403-416.
[18] M.L. Glaesener, G. Caruso, Neighborhood green and services diversity effects on land prices: Evidence from a multilevel hedonic analysis in Luxembourg, Landscape and Urban Planning, 143 (2015) 100-111.
[19] L.M. Brander, M.J. Koetse, The value of urban open space: Meta-analyses of contingent valuation and hedonic pricing results, Journal of Environmental Management, 92 (2011) 2763-2773.
[20] J.F. Chamblee, P.F. Colwell, C.A. Dehring, C.A. Depken, The Effect of Conservation Activity on Surrounding Land Prices, Land Economics, 87 (2011) 453-472.
[21] N.R. Magliocca, D.G. Brown, V.D. McConnell, J.I. Nassauer, S.E. Westbrook, Effects of alternative developer decision-making models on the production of ecological subdivision designs: experimental results from an agent-based model, Environment and Planning B-Planning & Design, 41 (2014) 907-927.
[22] Chan, E.H.W. and Lee, G.K.L. (2008). Contribution of urban design to economic sustainability of urban renewal projects in Hong Kong. Sustainable Development, Volume 16(6) (p 353-364)
[23] E.S. Williams, W.R. Wise, Economic Impacts of Alternative Approaches to Storm-Water Management and Land Development, Journal of Water Resources Planning and Management-Asce, 135 (2009) 537-546.