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Valuation of Urban Environmental Amenities in Developing Countries: A Case Study from Chandigarh, India

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VALUATION OF URBAN ENVIRONMENTAL AMENITIES IN DEVELOPING COUNTRIESA CASE STUDY FROM CHANDIGARH, INDIA

Strictly as per the compliance and regulations of :

Valuation of Urban Environmental Amenities in Developing Countries: A Case Study from Chandigarh, India

Pradeep Chaudhry [α], M.P. Sharma [σ], G. Singh [ρ] & Arun Bansal [ω]

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Keywords : hedonic price method, urban lake, green spaces, urban forests, environmental amenities, residential property valuation.

I. Introduction

World is rapidly urbanizing and it is expected that half of the population of Asia will live in urban areas by 2020, while Africa is likely to reach 50 % urbanization rate in 2035. Population growth is largely becoming an urban phenomenon in the developing world (Satterthwaite, 2007; U.N, 2012). India is not lagging behind on urbanization front. About 25.72 % of country's population lived in cities and towns in 1991 which increased to 27.86 % during 2001 and 31.16 % in 2011(Bhagat, 2011).Urban environmental amenities like green spaces, urban forests, lakes, wetlands and rivers are under severe stress as the people move towards cities for better employment opportunities and schooling of their children. All these activities cause increased urban sprawl leading to more noise, water and air pollution. New and planned cities in India like Chandigarh and Gandhinagar have special provision for creation of urban parks/gardens and water bodies in their respective master plans but this is not the case with majority of other cities. With the advent of education and environmental awareness, demand for urban nature and environmental resources is growing gradually in developing countries (Jim and Chen, 2006; Kong *et al.,* 2007; Jim and Chen, 2007).

Urban parks/gardens, wetlands, rivers and good environments provide intangible benefits that contribute to the quality of urban life (Bouland and Hunhammar, 1999; Shafer *et al.,* 2000; Chiesura, 2004). Environmental economists have devised various methods to quantify values of such non-market or intangible benefits of urban tress and water bodies to the society (Adamowicz *et al.,* 1994; Wilson and Stephan, 1999; Price, 2000; Woodward and Wui, 2001; Boyer and Polasky, 2004; Bin, 2006; Qiu *et al.,* 2006 and Tapsuwan *et al.,* 2009). Methods like Contingent Valuation Method (CVM), Travel Cost Method (TCM) and Hedonic Pricing Method (HPM) have been more popular, used and improved in recent decades. CVM falls under direct methods or 'stated preference methods' category whereas TCM and HPM fall under indirect methods or 'revealed preference methods' category. In CVM, a hypothetical market is created before a respondent who tells about his/her willingness to pay for a particular amount of non market commodity e.g. for a given quality of water in a river or lake, air quality or urban greenery at a particular location. However, as the responses do not involve actual market purchases, the responses of the respondents are based on hypothetical rather than actual behavior (Tyrvainen and Vaananen, 1998). Moreover CVM should be used very carefully with respondents in developing countries (Chaudhry *et al.,* 2007) because the chances of getting reliable results with CVM are low in developing countries and indirect methods like TCM and HPM are likely to yield more reliable results (Chaudhry and Tewari, 2006). In TCM, the people or tourists must reach a recreation site or resource from different distances after spending travel and time expenses, otherwise, this method does not work well (More *et al.,* 1988). Indirect methods like TCM and HPM make use of substitute markets to find

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out individual preferences (Garrod and Willis, 2000). The HPM links property values and the presence of features like lakes/wetlands/streams/green spaces with variables such as distance, view or access. Quality of these features can also be one of the variables. The purpose is to take into consideration a bundle of factors that affect house prices (Choumert and Salanie, 2008). HPM has been used extensively in USA and European countries to value urban greenery, water bodies and combination of these items (Mahan *et al.,* 2000; Loomis and Feldman, 2003; Garrod and Willis, 1992; Tyrvainen and Miettinen, 2000; Luttik, 2000, Tajima, 2003 and Morancho, 2003). Among developing countries, researchers in China have achieved a commendable progress in valuation of urban environmental attributes e.g. Jim and Chen (2006), Kong *et al.,* (2007), Jim and Chen (2009), Jiao and Liu (2010). However, India is lagging behind on this front as evident from only two studies which were conducted in Mumbai and Bhopal cities, regarding the valuation of urban environmental attributes (Gupta and Mythili, 2010; Verma and Negandhi, 2011).

The main objective of the present communication is to assess the environmental factors which make a location attractive to live in, particularly, in a planned city of a developing country like India and to assist urban land use planning with emphasis on urban nature conservation like green spaces and water bodies. Another objective is to find out the possibility of revenue generation for the conservation of Chandigah city's environmental attributes using Hedonic Pricing method.

II. Theoritical Background of HPM

The hedonic theory was first introduced by Rosen (1974), summarized by Freeman (1979, 1985) and later by Palmquist (1991). Hedonic Price Method/Model (HPM) is based on the hypothesis that goods are actually aggregations of characteristics features and that the demand for goods relates to these characteristics features. For example, price of a house/flat in a locality depends on market components e.g. size of plot, number of rooms, number of balconies, number of bathrooms etc and non market components like air quality, nearness to water bodies, parks/gardens, exposure to traffic noise etc. Hedonic price models have been developed to quantify the contributions of the market and non market components of a particular good to its market price through statistical analysis. People often pay more for a charming view if two houses are identical except for the views and the extra payment can be estimated as the value of the aesthetic and recreational service. In practice, many attributes jointly contribute to the selling price of a house. Statistical techniques have been developed to separate parts of transaction prices due to each contributory attribute (Jim and Chen, 2006).

In general, the purchase price of heterogeneous housing goods could be expressed by a hedonic pricing method which embraces a bundle of housing characteristics:

$$P = f(X_1, X_2, \text{--------}, X_n, Z) \quad (1)$$

where P is the market price of house and X_1, X_2,-------X_n are the structural and locational characteristics the house embodies and Z is the environmental variable without a market price (the hedonic variable). The partial derivatives of the price with respect to the constituent variables provide information on the marginal willingness to pay for an additional unit of each characteristic (Palmquist, 1991; Garrod and Willis, 2000; Sheppard, 1999 and Malpezzi, 2003). As a result, the implicit price of individual characteristics could be deduced (Jim and Chen, 2006). HPM is based on assumptions that the observed prices reflect equilibrium conditions in the market. Secondly, the model assumes that both the buyers and sellers of properties have perfect information about the market and non market components of the good (Sarker and McKenney, 1992). HPM is based on actual transaction behaviors in the market and is considered to be the most convincing approach to quantify amenity value (Hoevenagel, 1994; Ready *et al*, 1997; Hidano, 2000; Tajima, 2003 and Jim and Chen, 2006).

The HPM typically makes use of multiple regression analysis to relate housing price details with diverse characteristics of different properties and to find out the different contributions. Enough guidance is not available in economic theory about the choice of functional form which connects housing price with multiple attributes including structural, locational and environmental attributes (Rosen, 1974; Freeman, 1979; Halvorsen and Pollakowski, 1979). Therefore, it is better to try several functional forms like linear, semi-logarithmic, double logarithmic and Box-Cox while using multiple regression technique (Cassel and Mendelsohn, 1985). Each functional form has its own merits and demerits e.g. Box-Cox transformation could provide better results in terms of better fit of data than other transformations, but requires complicated transformation processes which could result into random errors (Davidson and MacKinnon, 1993; Jim and Chen, 2006). Three functional forms i.e. linear, semi logarithmic and double logarithmic have been tried for the analysis and results obtained from best form in terms of R^2 and least standard error estimate are presented in the paper.

III. About Chandigarh City

Chandigarh, the City Beautiful, is India's first planned city constructed after 1947 when country got independence. A number of famous town planners remain associated with concept and planning of the city e.g. Albert Mayer and Matthew Nowicki from America, Le Corbusier from France and English nationals E. Maxwell Fry, Jane and Pierre Jeanneret. Le Corbusier played major role till the city came to life. The construction of the city began in 1952 and Dr. Rajendra Prasad, the first President of India, inaugurated the city on October 7, 1953. Located at the foothills of the picturesque Shivalik mountain ranges, the city is an epitome of tradition blended with modernity. In the city's master plan, trees and plants are as much a part of the construction plans as the buildings and the roads. The geographical area of the city is 114 km^2, supporting a population of more than one million as per latest census of India in 2011. The basic unit of urban planning is the 'sector' and the entire city has been designed with an ordered framework of 'sector' that looks like a chess board (Figure 1). The dimensions of most of the sectors are 120m x 80m except the sectors located just near the Sukhn lake. The Sukhna lake is an artificial lake constructed in 1958 with a water spread area of about 2.50 km^2. This lake is one of the important tourist spots of the city with 'good' water quality according to National Sanitation Foundation Water Quality Index (NSFWQI) criteria (Chaudhry *et al.,* 2013 (A and B)).

Figure 1 : Chandigarh city map showing sectors, green spaces and Sukhna lake

Chandigarh is a fully grown city of modern architectural splendor and nestles in a picturesque setting in the foothills of the Shivalik mountains. The city has attracted people from nearby states of Punjab, Haryana and Himachal Pradesh over the years due to its educational, environmental and career oriented facilities. Le Corbusier designed the city for a population of 0.5 million but now the population has gone over 1 million as shown in Figure 2.

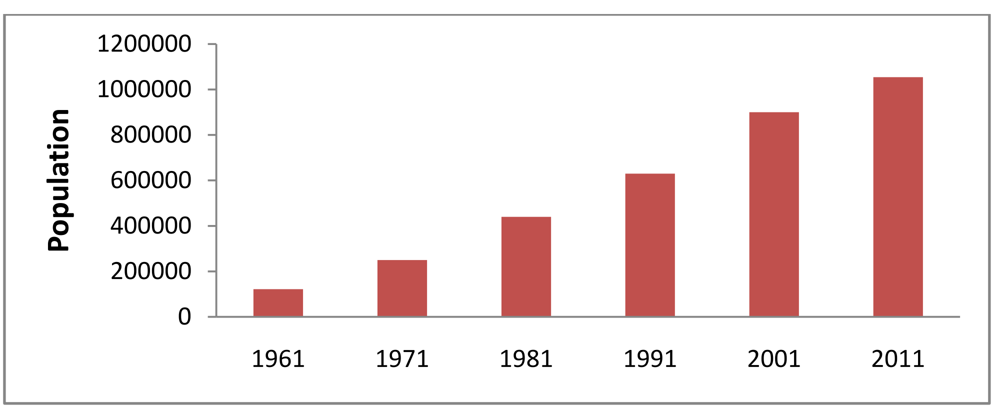

Figure 2 : Population of Chandigarh city between 1961 to 2011

Chandigarh has the largest numbers of vehicles per capita in India. The data provided by the Registering and Licensing Authority, Chandigarh administration, indicates that the number of vehicles per household is two (D.O.E, 2008). Increasing numbers of petrol and diesel vehicles in the city are causing significant decrease in ambient air quality. The number of vehicles in Chandigarh has risen from 5, 73,035 in 2004 to 8, 29,145 in 2011 i.e. an increase by over 40 % in a span of seven years (Figure 3).

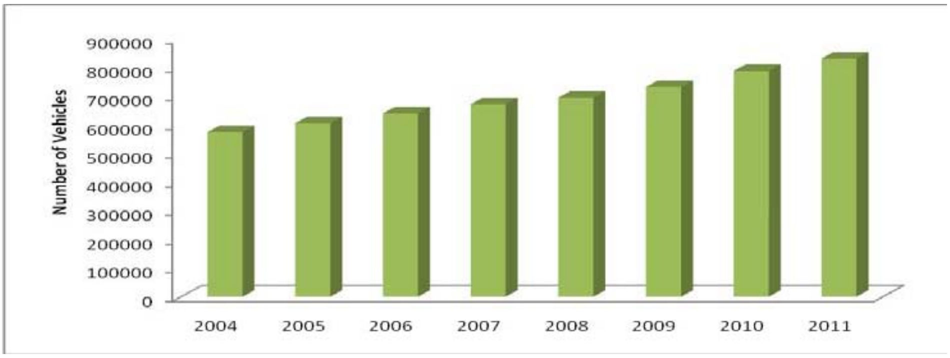

Figure 3 : Rise in number of vehicles in Chandigarh city

IV. Materials and Methods

Based on a sample size of 176 numbers of urban residential plots located in different sectors of Chandigarh city, details regarding prevailing rate (Rs/sq yard)*, overall price (Rs) and plot size (yard) were collected from residents and property dealers of the city. Numbers of residential plots between 4 to 5 were covered in different (40) sectors of the city for collecting above details. Sectors like 1, 6, 12, 14, 17 and 25 were not considered as no private residential plots are located except mostly the governmental, educational and commercial properties (Figure 1). Sectors adjoining Mohali city of Punjab were also not covered as the multi-storied flats are mostly located here whereas maximum of city's geographical area is devoid of private multi-storied flat culture. Further the city areas around Manimajra, Halomajra, Ram darbar, airport and railway station vicinity were also not considered for primary data collection as no systematic residential sectors are formed in these areas. In addition to above details regarding residential plots, primary survey was conducted in different sectors of the city among residents to find out status of air quality, drinking water quality and its availability round the year, exposure to traffic noise, quality of sector parks/gardens and general garbage removal around living areas of the residents. Secondary data about air quality and noise pollution in residential areas of different sectors was also collected from Chandigarh Pollution Control Committee (CPCC), Department of Environment, Chandigarh administration. Deputy Commissioner, Chandigarh office was approached for finding out 'collector rate' applicable to sale and purchase of residential property in the city. Collector rate comes into picture when a particular property is sold or purchased and property registration is required to be done at rates equal or higher than the applicable collector rate. Property registration ensures a kind of revenue for the local administration.

*The residential plot rates are expressed in Rupee per sq yard in the region in and around the Chandigarh city.
One sq yard=0.8361 sq metre or one sq metre=1.196 sq yard.

V. Results and Discussion

The city area from sector 2 to 47 was divided into four (4) zones from 'zone 1' to 'zone 4' based on existing market rate of plots found during the survey. The survey was conducted during the period Oct 2012 to Dec 2012. It is observed that zone 1 near Sukhna Lake has the highest average plot rate of Rs 1,76,000 per sq yard, followed by Rs 1, 52,000 for zone 2, Rs 1,33,000 for zone 3 and Rs 1,12,000 for zone 4 (Figure 4).

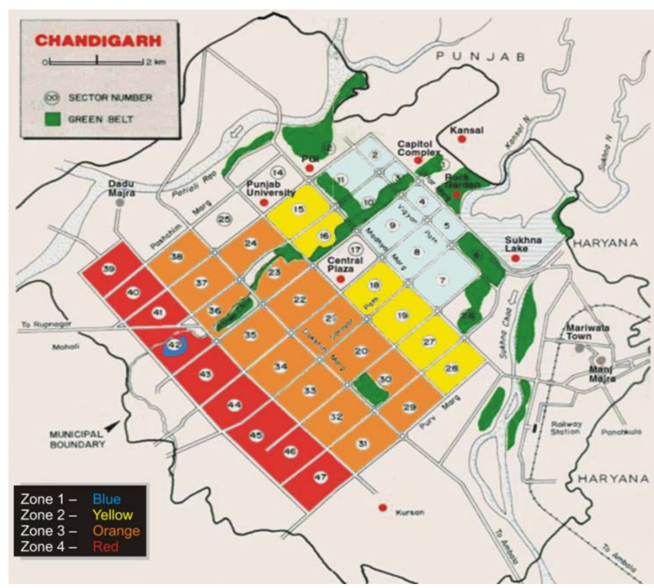

Figure 4 : Division of Chandigarh city area in to four zones

Sample number of plots considered in different zones, maximum, minimum and mean size of plots, maximum, minimum and mean rate of plots in a particular zone and mean distance from Sukhna Lake are given in Table 1, where it is observed that mean rate of residential plots decreases as the distance from Sukhna lake increases.

Table 1 : Details about number of plots, sizes, rates and distance from lake

Details	Zone 1	Zone 2	Zone 3	Zone 4
No of residential plots considered	40	32	68	36
Mean size (sq yard)	1590	575	315	200
Max size (sq yard)	4000	2000	1000	500
Min size (sq yard)	250	200	125	100
Mean rate (Rs /sq yard)	1,76,000	1,52,000	1,33,000	1,12,000
Mean plot price (Rs million)	280.00	87.40	41.80	22.40
Mean distance from lake (m)	1300	2560	4437	6090

ANOVA has been used to compare the means of three or more than three unrelated groups, using F statistics was applied. Variables considered were rate, price, size and distance of residential plots from the Sukhna lake. Higher value of F statistics implied that samples were drawn from populations with different mean values. The respective values of F statistics ($p < 0.01$) indicated that the division of the geographical area of the city under consideration (i.e. Sector 2 to 47) into four zones (zone 1 to 4) based on the above variables is statistically correct.

The definitions of the dependent variable (RATE) and 8 explanatory variables included in this study are presented in Table 2. One variable i.e. size of residential plot (PLOTSIZE) is related to the structural characteristics and the rest are environmental variables. Last five variables are dichotomic in nature that takes the value of 1 or 0 i.e. 1 for good air and water quality and 0 for bad quality. Similarly 1 is adopted for low traffic noise and 0 for higher noise disturbance. Variables other than PLOTSIZE can also be called hedonic variables as their inclusion in the price equation allows us to assess the influence of environmental attributes on housing market value.

Table 2 : Variables related to plots and their environs

Variable name	Definition	Unit
RATE	Market rate of residential plots in different sectors	Rs per sq yard
PLOTSIZE	Size of residential plots	Sq yard
DISTLAKE	Distance of plot from Sukhna Lake	m
DISTLVALLEY	Distance of plot from Leisure valley chain of parks/gardens	m
AIRQUALITY	Quality of air in the vicinity of plot	0,1
NOISE	Exposure to traffic noise	0,1
GARBAGE	Garbage removal facility from house & in the vicinity of plot	0,1
WATERQUALITY	Quality and availability of drinking water during the year	0,1
QUALITYSECPARKS	Quality of sector parks in comparison to Leisure valley	0,1

Leisure valley chain of parks and gardens consists of number of linear parks and theme gardens developed along eight km stretch of a seasonal rivulet running across the city (Figure 1). Various parks and gardens developed along this rivulet include Rajendra Park (16,19,400 m^2), Bougainvillea Garden (80,970 m^2), Leisure Valley Garden and Fitness Trail (3,80,566 m^2), Zakir Rose Garden (21,450 m^2), Shanti Kunj (72,875 m^2), Bamboo Valley Garden (1,11,336 m^2), Bulbous Garden (28,340 m^2), Hibiscus Garden (16,194 m^2), Fragrance Garden (40,486 m^2) and Dahlia Garden (18,318 m^2). These parks/gardens are in addition to numerous small and big sector parks and green belts in the city. Due to the strategic location and importance of the Leisure valley chain of parks/gardens, the distance of residential plots from Leisure valley chain of parks/gardens (DISTLVALLEY) has been taken as one of the hedonic or environmental variables in the present study.

Various hedonic pricing studies involving influence of environmental amenities with either water bodies or green spaces or both as main ingredient on housing prices in developed (Luttik, 2000; Mahan *et al.,* 2000; Paterson and Boyle, 2002; Price, 2003; Tajima, 2003; Morancho, 2003; Tapsuwan *et al.,* 2009) and developing countries (mainly China e.g. Jim and Chen, 2006; Kong *et al.,* 2007; Jim and Chen, 2007) have been conducted with 'price' or 'rate' of residential flats as dependent variable. Present study is the first of its kind where 'rate' of 'residential plots' has been taken as dependent variable. Further, locational variables like nearness to schools, workplace and market have not been considered in the study. This is mainly due to two reasons. One, the city area is not very large (114 km^2) and secondly, the public transport system in the form of government owned local buses is good. The 'Transport Performance Index' of Chandigarh city is highest among

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major cities of India (Figure 5; Department of Environment, 2008). Moreover, Chandigarh has also the highest density of private vehicles (two and four wheeled) in India (Department of Environment, 2008).

Figure 5 : Transportation Performance indices of different cities of India

Table 3 gives the estimation of double log model using weighted least square (WLS) method. Statistical Package for Social Sciences (SPSS 16.0 for Windows) was used for regression analysis. Variable 'zone' was used as the source variable for the weight in above software. In double log form, natural log is applied on both sides of the equation (except on dichotomic variables) describing relationship between price or rate of housing to various variables. The set of explanatory variables was found to account for more than two third of the rate variance (Adj R^2 = 0.678) and the F ratio test indicated that model fits properly. The results indicate that all independent variables are significant except exposure to traffic noise and garbage removal variables. A close look at the Student's t-statistics reveals that distance from the lake was most significant variable affecting the rates of residential plots. Rates of plots decrease @ 10.5 % per zone as the distance from lake increases. This trend is also evident from Table 1. If the rates of plots are analyzed with the linear distance from Sukhna lake, it is found that the rates decrease @ 1600/- per sq yard for every 100 m distance upto 3000 m and @ 800/- per sq yard for every 100 m from 3000 to 6000 m (Figure 6). The steeper slope of curve upto 3000 m and relatively gentle slope after 3000 m indicates a clear positive effect of lake proximity on residential property.

Table 3 : Multiple regression analysis results using WLS method (double log form)

Independent variable	Coefficient	t-ratio	p-value
ln PLOTSIZE	-0.024	-1.90	0.05
ln DISTLAKE	-0.105	-5.54	0.00
ln DISTLVALLEY	-0.019	-2.36	0.01
AIRQUALITY	0.031	3.72	0.00
NOISE	0.00	0.00	0.99
GARBAGE	0.00	-0.05	0.95
WATERQUALITY	0.048	5.10	0.00
QUALITYSECPARKS	0.068	4.05	0.00
CONSTANT	12.64	51.92	0.00

Adj R^2 =0.678, F=46.98 ($p<0.00$), Log-likelihood function value=160.982, n=176

Source variable for weighting=Zone, Dependent variable=ln RATE

However, the rates of plots decrease at lesser rate of 1.9 % per zone as distance from Leisure valley chain of parks/gardens increases. This means that the effect of lake proximity is more influential on property prices than the green belt. Similarly, the rates of plots decrease @ 2.4 % as plot size increases (Table 3). This is a general feature in Indian property market in majority of cities where smaller size residential plots fetch higher selling rate. If the rate of plots is analyzed with linear distance from Leisure valley, it is observed that rates decrease @ 800/- per sq yard for every 100 m distance (Figure 9). Among other environmental variables, drinking water quality, its availability round the year and air quality are affecting the rates of property as the zones nearer to lake have the advantages of having better quality of air and drinking water availability. Quality of sector parks was also as an important variable (t-statistics=4.05), indicating comparatively better quality of sector parks in areas near to the lake and poorer quality in southern sectors of the city which are away from the lake.

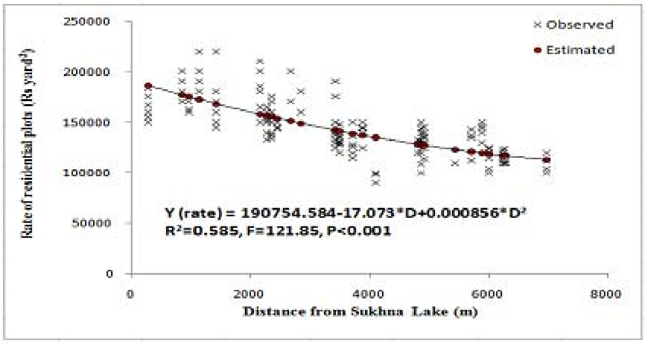
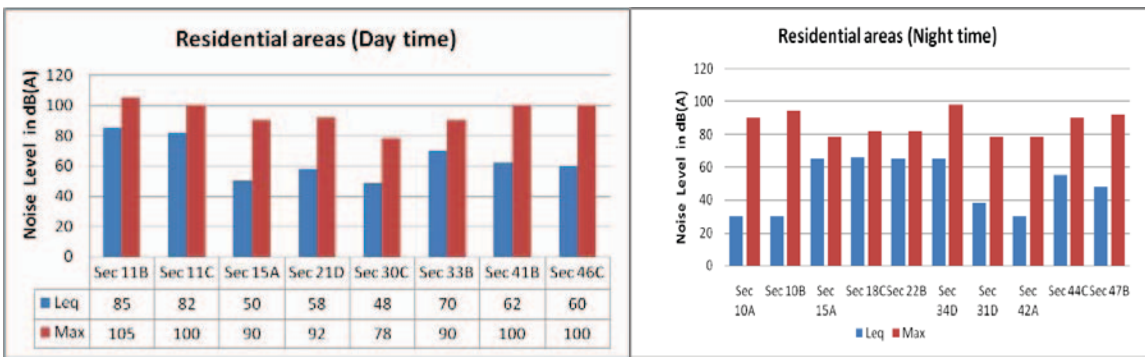
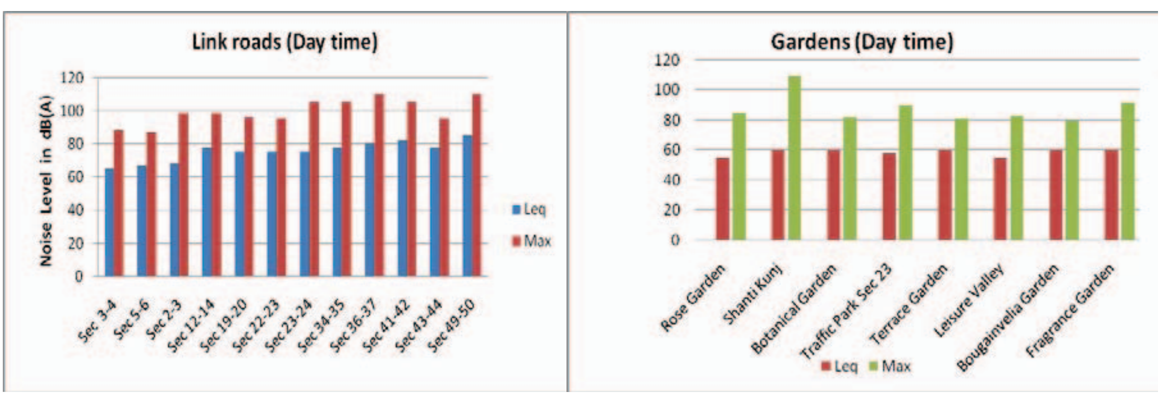


Figure 6 : Variation of residential plot rates vs distance from Sukhna Lake. 'Y' is rate of residential plots (Rs per sq yard) and D is distance from lake

The traffic noise was not found to influence the rates of plots. This finding is similar to the finding in Chinese city of Guangzhou (Jim and Chen, 2006) but opposite to European countries (Luttik, 2000). People of the city found traffic noise present in almost all the areas, except few pockets near Zone 1 and 2. Secondary data from CPCC of Chandigarh administration also points out towards the same fact (Department of Environment, 2008). Noise level in the city during day and night times in residential areas and at link roads remains generally higher than the permissible limits of 55 dB(A) and 45 dB(A) respectively (Figures 7a, 7b and 8a). However, various gardens/ parks in the city display relatively calm areas (Figure 8b).



Figures 7a & 7b : Noise level in residential areas of Chandigarh city



Figures 8a & 8b : Noise level at link roads and gardens of Chandigarh city

Household garbage collection was not a problem for majority of houses as garbage collectors were coming regularly but it was the heaps of garbage around community garbage bins or containers along roads and green belts that were creating the problems for the residents. Another common problem was non-regularity of sweepers on the roads most of the times and lack of their supervision. Residents of the city considered stray cattle, dogs and monkeys also responsible for littering garbage from common bins in different sectors and presenting unhygienic situations. This problem was found prevailing almost all over the city with some marginal improvement in northern sectors near the lake. Therefore, in present analysis, the traffic noise and garbage removal were found as insignificant variables affecting the rates of residential plots in the city.

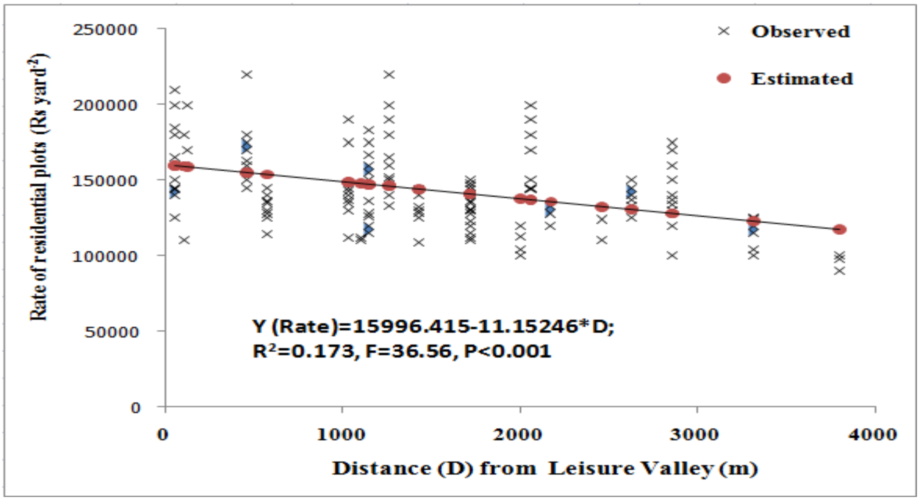


Figure 9 : Variation of residential plot rates vs distance from Leisure Valley. 'Y' is rate of residential plots (Rs per sq yard) and D is distance from Leisure valley

Almost similar results were found when multiple regression analysis was conducted using ordinary least square (OLS) method with double log functional form (adj R^2 = 0.69, F = 50 ($p<0.00$)). Distance from lake was again found most significant variable (t-statistics = 5.55). Exposure to traffic noise and garbage removal were again found insignificant variables (Table 4).

Table 4 : Multiple regression analysis results using OLS method (double log form)

Independent variable	Coefficient	t-ratio	p-value
ln PLOTSIZE	-0.033	-2.67	0.00
ln DISTLAKE	-0.101	-5.55	0.00
ln DISTLVALLEY	-0.022	-2.64	0.00
AIRQUALITY	0.032	3.59	0.00
NOISE	0.00	-0.048	0.96
GARBAGE	0.00	0.127	0.89
WATERQUALITY	0.051	5.31	0.00
QUALITYSECPARKS	0.074	4.193	0.00
CONSTANT	12.66	54.31	0.00

Adj R^2 =0.69, F=50.00 ($p<0.00$), Dependent variable=ln RATE, n=176

Ambient air quality of Chandigarh city is under pressure since last three decades due to increase in vehicle population. Respirable Suspended Particulate Matter (RSPM) in the city is crossing its permissible limits in all the residential areas where monitoring is done by CPCC. However, the SO_2 and NO_X levels are within permissible limits (Figures 10, 11, 12).

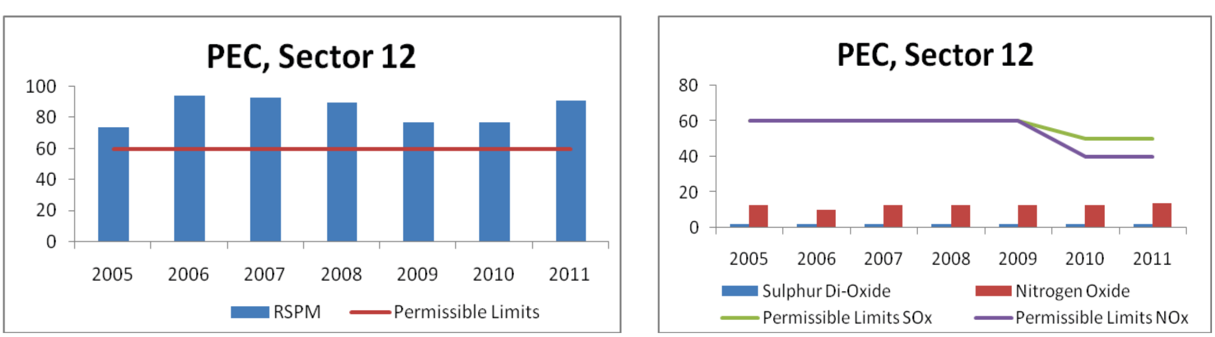


Figure 10 : RSPM, Sulphur Dioxide and Nitrogen Oxide concentrations in zone 1

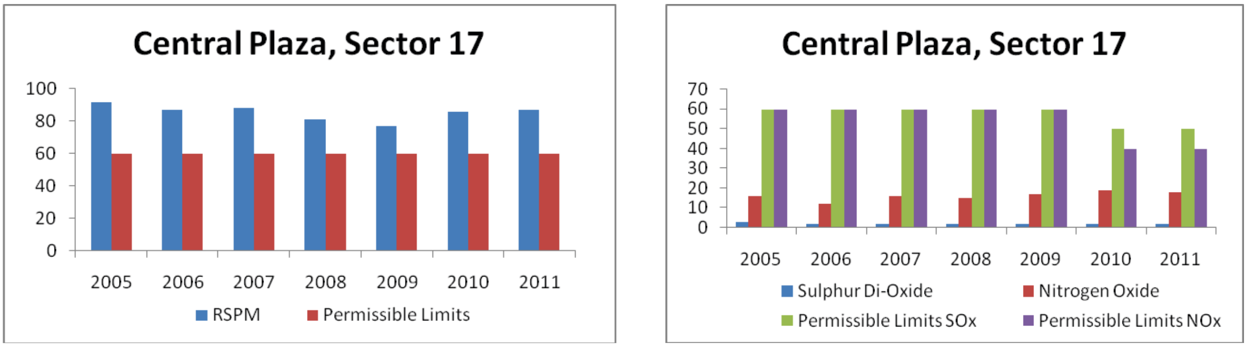


Figure 11 : RSPM, Sulphur Dioxide and Nitrogen Oxide concentrations in zone 2

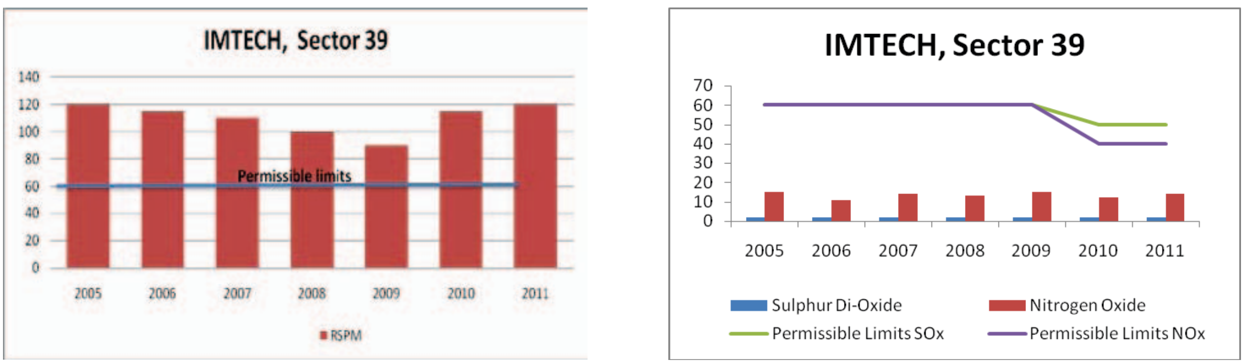


Figure 12 : RSPM, Sulphur Dioxide and Nitrogen Oxide concentrations in zone 4

a) Urban greenery and its environmental effects

As per the two analysis by WLS and OLS method, air quality is found as good in areas nearer to lake and Leisure valley i.e. zones 1 and 2. Air pollution monitoring stations at Punjab Engineering College (PEC) University of Technology, Sector 12 (zone 1) and Central Plaza, Sector 17 (zone 2) of Chandigarh city recorded comparatively lesser average annual RSPM concentration in comparison to those recorded at Institute of Microbial Technology (IMTECH), Sector 39 (zone 4) as evident from Figures 10, 11 and 12. Probable explanations for this are not difficult to find. First, the density of human population n, vehicles and number of plots are less in this region (due to comparatively bigger size plots in comparison to zone 3 and 4). Secondly, more road side greenery, tree avenues, boulevards and parks/gardens in the form of Leisure Garden chain are available in zone 1 and 2 like Rajendra Park, Bougainvillea Garden, Fitness Trail, Zakir Rose Garden and Shanti Kunj (Figure 1). Quality of sector parks was also found comparatively well in zone 1 and 2 (Table 3 and 4). In fact, Chandigarh city is among top India's cities having forest and tree cover of more than 35 % of its area and per capita green space availability around 55 m^2 (Chaudhry and Tewari, 2011; Chaudhry *et al.,* 2011). Maximum of this forest and tree cover is concentrated around zone 1 and 2 (Figure 1).

The enhancement of urban vegetation is one of the ways, which has the potential to mitigate the adverse effects of urbanization, mainly air pollution, in a sustainable manner. Nowadays there is an increased societal demand for more green areas in and around cities (Ridder *et al.,* 2004). Many studies conducted in developed and developing countries support this view. According to a research conducted in Santiago city of Chile which is facing worst urban air pollution in Latin America, managing municipal urban forests (comprising trees, shrubs, and grass) to remove suspended particulate matter (PM_{10}) was a cost effective policy for abating PM_{10} based on criteria set by the World bank (Escobedo *et al.,* 2008). In a study conducted in USA, it was found that atmospheric pollution worth more than 7,00,000 metric tons per year was removed in 55 cities of the country by the urban vegetation (Nowak et al., 2006). Urban forests of Guangzhou city of China, covering an area of 7360 ha, removed 312 metric tons of atmospheric pollution annually, out of which PM_{10} accounted for 234 metric tons (Jim and Chen, 2008). Similarly, urban greenery of Beijing, China with 4.5 million human population, was responsible for removal of 1261 metric tons of environmental pollution every year, out of which 776 metric tons were particulate matter (Yang *et al.,* 2005).

Two way ANOVA was performed with 'rates' of plots as dependent variable and 'distance from Leisure valley chain of parks/gardens' and 'distance from lake' as fixed factors. For distance from Sukhna lake, the following groupings were adopted i.e. 0 to 1500 m, 1501 to 3000 m, 3001 to 4500 m, 4501 to 6000 m and > 6000 m. For distance from Leisure valley chain of parks/gardens following groupings were made i.e. 0 to 200 m, 201 to 600 m, 601 to 1500 m, 1501 to 2000 m and >2000 m. Duncan multiple range test (DMRT) was used to find effect of 'zone' and 'distance from L.valley' on Air quality. It is found that about 77 % of residents up to 1500 m from L.valley were satisfied with air quality, whereas < 53 % residents were satisfied with air quality at far away places i.e. >1500 m distance from L.valley. Duncan multiple range test (DMRT) was also employed to find the effect of 'zone' and 'distance from lake' on air quality. It was found that > 73 % of residents were satisfied from air quality upto a distance of 3000 m from lake and less than 54 % were satisfied as distance from lake increased more than 3000 m. When 'quality of sector parks' was selected as dependent variable, it was noticed that nearly cent percent residents are satisfied with quality of sector parks upto 1500 m from the lake and up to two thirds were satisfied upto 3000 m from the lake. Less than one third of residents were satisfied with quality of sector parks after 3000 m distance from lake. Above analysis shows that 'zone 1' and 'zone 2', which enjoy nearness to S. lake and Leisure Valley, constitute the best region of the Chandigarh city as far as the air quality and urban greenery are concerned (Figure 4). The Sukhna lake has an attractive dam promenade with lot of trees, shrubs, herbs and lawns over it. A road nearby allows walking by visitors and sightseeing of the lake with tropical deciduous forests in the background, adding to recreational and aesthetic value of the spot. Therefore, it is not surprising for the zones 1 and 2 of the city to have highest residential property value. Such green spaces provide recreational and leisure opportunities to the residents and tourists (Tzoulas and James, 2010). They serve as an important place for the people to meet and have social get-togethers (Seeland *et al.,* 2009).

b) Scope of revenue generation

Current government approved collector rate for all the urban residential areas in the Chandigarh is uniform @ Rs 54,912/- per sq yard (Chandigarh Administration, 2012). This rate is very less in comparison to prevailing residential property market rates in zone 1 to 4 (Table 1). Ideally, the collector rate should be very near to prevailing market rate of the property. The huge gap not only leads to the loss of government revenue in the form of stamp duty and registration charges applicable for selling/purchase of such property, it also encourages circulation of black money in the economy as investment in real estate is one of the most favorable options for the persons/firms having black money. Use of unaccounted money in property market in India has become a major problem (Nayar, 1996; Kumar, 1999; Bhigania, 2012). Hence, there is an immediate need to enhance the present collector rate for urban residential property in the city from Rs 54, 912/- per sq yard to at least Rs 1,50,000/- for zones 1 and 2 and to Rs 1,00,000/- for zones 3 and 4. This means an increase of about 173 % for zone 1 and 2 and about 82 % for zone 3 and 4. The Chandigarh administration can take a clue from Government of National Capital Territory (NCT) of Delhi where the property prices for category A (posh areas like Defence colony, Greater Kailash, Gulmohar Park, Golf links, Green Park etc) were increased by 200 % and for category B (areas like Kalkaji, Andrew ganj, Munirka vihar etc) by 50 % in December 2012 (Delhi Administration, 2012). A comparison regarding percent increment in such rates in two cities shows that Delhi Government has been following more pragmatic and practical approach in property matters than Chandigarh administration (Table 5).

Table 5 : Comparison of percent increase in urban property rates in Chandigarh and Delhi

City	Remarks	Year 2010	Year 2011	% Increase	Year 2012	% Increase
Chandigarh	Uniform rates all over the city	Rs 39,936 per sq yard	Rs 49,920 per sq yard	25	Rs 54,912 per sq yard	10
Delhi	Category A	Rs 86,000 per sq m	Rs 2,15, 000 per sq m	150	Rs 6,45,000 per sq m	200
	Category B	Rs 68,200 per sq m	Rs 1,36,400 per sq m	100	Rs 2,04,000 per sq m	50

Extra revenue generated, thereby, can be utilized for creating better parks/gardens in sectors devoid of greenery, maintaining the existing parks/ gardens and the lake. This will help in curbing increased air and noise pollution, as it has been proved not only in developed countries but also in a densrly populated city of Dhaka, Bangladesh, a developing country where the research concluded that urban vegetation was very effective in controlling air and noise pollution (Islam *et al.,* 2012).

Local city municipalities in developing countries often fell short of budget for urban nature conservation related works. In developing countries, research studies related to valuation of urban environmental amenities are scanty (Jim and Chen, 2006). Present study is a small step in this direction and provides significant information about people's attitude and behavior towards such amenities in a developing country like India. More and more such studies should be conducted in different cities of the country, wherever possible, to provide scientific justification and platform for generating revenues for creating and maintaining the urban nature components like lakes, wetlands, parks and gardens.

VI. Conclusions

Very few studies are available involving valuation of urban environmental amenities in develop-ping countries including India. These environ-mental amenities include water bodies, clean air and urban forests. Quantification and valuation of environ-mental, social and economic values of these attributes has remained a difficult task. This study is an effort to extract and value the environmental externalities embodied in housing market of Chandigarh city. Municipalities in developing countries always struggle in financing urban nature conservation projects. Attempts were made in this study to establish that the local municipalities and city administration can generate sufficient revenue to further consolidate urban nature elements and provide better quality of urban life and recreational /leisure opportunities to the citizens. This study can also serve as a model for future city planning in the country as the city planners, architects and policy makers can consider the information about the utility of water bodies and urban green spaces in urban land use planning. It is expected that the results of the present study will boost future research about the valuation of the urban environmental amenities in Indian cities.

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