Trend analysis of the Land Price at Bengaluru Metropolitan Area in India

V.Sampathkumar[1], J.Vanjinathan[2]
[1]*Professor, Department of Civil Engineering, Sathyabama Institute of Science and Technology, Chennai, 600 119, India*
[2]*Assistant Professor, Department of Civil Engineering, Sathyabama Institute of Science and Technology, Chennai, 600 119, India*

Abstract **- This paper focuses on the modeling and forecasting of land price in Bengaluru Metropolitan Area, Karnataka, India using multiple regression and neural network techniques. Six locations spread over Bengaluru Metropolitan Area are selected at random as study area. The monthly average values of the selected factors from the year 2001 to 2015 are considered to develop the models. Both multiple regression and neural network models are validated with the market price in the year 2014 and 2015. After validation the models are used to forecast the land price in Bengaluru Metropolitan Area for the years 2016 and 2020. Both the models are found to be well fit for the modeling of land price; however, the model using neural network shows better accuracy than regression technique.**

Index Terms **- Economical factors, land price forecast Modeling of land price, Model validation.**

I.INTRODUCTION

Land is one of the most precious assets satisfying primary needs for food and shelter. It is finite in extent and it is in growing demand and its value is expected to increase in the years to come. The price of land is determined by its production potential, and by the present or future services it incorporates. In modern times it has also become an object of speculation. To find the economic value of land it is compared with the recent sale of similar plots under similar conditions. It depends on the production potential of the land, and it is the basis for urban and industrial development. The land price in India has been booming and has emerged as a dynamic source of investment in the recent decades. The need for predicting the trend in land price was felt by everyone concerned viz. the Government, the regulating bodies, lending institutions, the developers and the investors. There is no well-defined mechanism to formulate and evaluate the property prices. Past data reveal that the price does not follow any pattern and a realistic scientific or mathematical modeling need to be done to predict to know the future trend.

Bengaluru is a district in the state of Karnataka from 1986 with the partition of Bangaluru district into Bengakuru urban and Bengaluru rural districts. Bengaluru urban has four taluks such as Bengaluru North, Bengakuru East,Bengaluru South and Anekal. The capital city of Bangaluru is situated in Bangaluru urban district, the most advanced district in the state with 89% of the population living in urban as reported in 2001. Bengaluru is the 5th largest and second fastest growing metropolis in India. The city's population has grown by 47% over the last decade and was attained one crore population in the year 2011 (Bengaluru City population 2011-2021)[1]. Huge investments, made by the Government were setting up public centre companies in 1970's have led to the concentration of technological and scientific centers in the city (The Bangalore Development Authority Act, 1976)[2]. Home to major information technology and biotechnology companies, the rapid urbanization of the city has led to skyrocketing land prices and increased demand for land parcels surrounding the city. At the same time, the city tries to maintain its status of being "The garden City of India" with an emphasis on public parks strategically located amidst crowded localities. The Bengaluru Metropolitan Region (Greater Bengaluru) covers an area of 1307 Sq.km while the Bruhat Bengaluru Mahanagara Palike covers an area of around 800 Sq.km with the population of the city being 8.43 million (2011 census), making Bengaluru the third most populous city. in India. The entire city is divided into 198 wards

for ease of governance and provision of municipal services.

Global consultancy firm Knight Frank's Prime Asia Development Land Index, which tracks the performance of residential and commercial land values across top Asian cities, shows that land for residential development in Mumbai has seen a whopping 35.2% increase over the last two years. This as the country's financial capital has seen a change in development norms coupled with increase in prime residential prices. The same Index for Bengaluru and the National Capital Region (NCR) has shown a growth of 26.1% and 24.9%, respectively. However, Mumbai's office development land index has shown a decline of 13.1% as a weak economic scenario impacted office space absorption coupled with large supply of office space. On the other hand, for NCR and Bengaluru, the index clocked a healthy growth of 16.3% and 12.9%, respectively. The report said that both the residential and office space indices for Bengaluru were reflections of an increase in prime property price, steady job growth and a healthy leasing market that caters to the office needs of IT/ITeS and non-IT / ITeS sectors (Times of India, 31/5/2014, Bengaluru is second land price appreciation)[3].

The price trends of Bengaluru show the overall direction of the real estate market. These trends help an investor to know whether it is the correct time to buy or sell their properties in Bengaluru. The average price of properties in Bengaluru is 68.50 lakhs per 5.5 cents. There are 244 localities in Bengaluru which are showing an upward price trend, Bengaluru has a price trend which is moving up since the past six months (Property Rates & Price Trends in Bengaluru – 2017)[4]. It shows the unit price of land at various locations in Bengaluru.

Table 1 Geography of Study Areas in Bengaluru

Locations	Area (Sq.km)	Latitude	Longitude
Hebbal	1.23	13°2'24" N	77°35'24" E
Marthahalli	3.10	12°57'22"N	77°42'7" E
Jigani	10.0	12°27'36" N	77°22'48" E
Kengeri	4.77	12°59'0" N	77°35'0" E
Koramangala	3.71	12°92'01" N	77°62'02" E
Devanahalli	27.4	12°58'0" N	77°34'00" E

II. STUDY AREAS IN BENGALURU

Investors' decisions are based on the market trends so as to obtain maximum returns. Market trend plays an important role in real estate. Large number of data which influences the land price is required for accurate estimate of property prices and their future trend and for analysis and modeling. The growth of Bengaluru has been unprecedented in the past couple of decades. Bengaluru has grown at average annual growth rate of 3.60% in the last three decades. This City has a ring and radial road pattern. All highways and district roads are radially converging into the core area. The state Karnataka contributes to the country's GDP has increased from 5.5% to 7% in the last years. The present study mainly focuses on the evaluation of interaction effects of economic attributes on land price, developing mathematical models and forecasting of land price at six different locations in Bengaluru Metropolitan Area (BMA). The list and address of study locations are shown in Table 1 and the locations are shown in Figure 1. Bengaluru has the second highest literacy rate (90%) for an Indian metropolis, after Mumbai. Continued influx of working population to Bengaluru City and lack of adequate response of the Government to meet the growing housing needs have gradually widened the demand and supply gap resulting in exponential increase in capital values of residential units making 'less affordable' to buy a home for large segment of the population. Bengaluru during the year 2000-2001 indicated about 39% of households had house ownership while 56% of the households were found to be in rented accommodation. It demonstrated the increasing demand for the rental housing in the city and reduced affordability of the population to have house ownership due to high capital values. Six study locations selected in such a way that, two locations from north and one from East zones and other three from South zone and the zonal distribution of study locations are shown in Table 2.

Hebbal is an assembly constituency area in Bengaluru, Karnataka. It is famous for Hebbal Lake, it is now better known for the serpentine maze of flyover that networks the outer ring road and Bellary Road. Marathahalli is a suburb of Bengaluru city. Since there is an IT boom, its close proximity to HAL airport, Whitfield, Sarjapur road and electronic city and the presence of the outer ring road,

Fig.1 Location of Study Areas in BMA

this area has boomed as a self-sufficient township. Jigani Hobli is located in Anekal at a distance of 43 km from Bengaluru city railway station. It has a well-established Jigani industrial area and also very near to electronic City in Bengaluru. Kengeri is the satellite town in Bengaluru City. It is about 14 km away from the city centre and lies on the Mysore Bengaluru Road. It is an evergreen state and a Toyota factory is also located here. Koramangala is situated in the southeastern part of the city. It is one of the largest neighbourhoods and mix of luxury apartments, commercial structures and a posh bungalow. It has gradually developed into a commercial hub. Koramangala is largely cosmopolitan in nature. Devanahalli, is located in northeast of Bengaluru. It is the site of the Bengaluru international airport, the second largest airport in India. A multibillion-dollar Devanahalli business park with two IT parks are there on nearly 400 acres adjoining to the airport.

III. REVIEW OF LITERATURE

Sampathkumar and Helen Santhi (2010)[5] studied the land price trend of Sowcarpet which is the central part of Chennai city. Urmila (2010)[6] reported that the past trends are analyzed to ascertain the rate of growth or decline, as the case may be and these trends are then used as a first attempt of forecasting. To accurately estimate property prices and future trends, large amount of data that influences land price was required for analysis, modeling and forecasting (Greg Brown & Pat

Table 2 Study Locations within Bengaluru

Zones	Name of the Locations
North	Hebbal, Devanahalli
East	Marthahalli
South	Jigani, Kengeri, Koramangala

Reed 2011)[7]. A study by Sampark Public Relations Pvt. Ltd (2011)[8] in their article revealed that the property price trends for the Chennai region had seen an escalation in 2011 over 2010. ICICI Property Services (2012)[9] reported that the micro markets closer to the city would continue to show homebuyer interest. ICICI Property Services (2013)[10] showed that over the long term, it was expected that the residential real estate prices in Chennai to increase at 7-10% every year. Bangalore's real estate market has outpaced the city's IT-twins Infosys and Wipro, belting out a record four quarters of double-digit growth in 2012-13 (TOI, 28/09/2013, Bangalore property sales surged in 2012-13)[11]. A simple analysis of the past data revealed that the prices show a non- linear characteristic (Todd BenDor 2014)[12]. Improved buyer sentiments along with end-user demand and infrastructural push kept Bangalore's real estate market relatively positive, as compared to other key markets in the country (Insite reports, Ref: https://www.99acres. com/articles/ bangalore-insite-report-apr-jun-2015.html). Most of these studies were done laying emphasis on physical factors and not much attention has been paid on modeling and forecasting the land price using economic attributes. The present study aims to bring out the significance of economic attributes

Table 3 List of independent variables

Variable names	Abbreviation
Gross Domestic Product (%)	GDP
Cost of Crude Oil ($)	Croil
Dollar equivalence to Indian currency (₹)	Doll
Rate of inflation (%)	Infla
Gold and Silver price per gram (₹)	Gold, Sil
Mumbai and National share index	BSE, NSE
Population in the study area	Pop
Interest rate on home loan (%)	HL
Unit cost of construction per Square foot (₹)	CC
Guideline value per ground (₹)	GLV
Time factor (Year and Month)	Time

pertaining to the modeling and forecasting of land price in BMA. Lists of such attributes which influence the land are shown in Table 3 and the market price of land is treated as dependent variable. From the study area the market price is collected at six locations spread over BMA. The selected areas lie in three zones of BMA, namely North, East and South. The factors include, Gross Domestic Product, Crude oil cost, Dollar equivalence to Indian currency, Rate of inflation, Metal price (gold and silver), Share index (BSE and NSE), rate of interest on home loan, Unit cost of construction, Guideline value of land coated by the authority and Time.

IV. DATA COLLECTION

Primary data has been collected through interviews and personal visits to the various mediating agencies to know the present situation of the market and the secondary data is collected mainly through various newspapers, magazines, Internet and RBI review. The transacted land price in lakhs of rupee per 5.5 cents (or) a Ground (or) 2400 Square feet in the study locations are collected as primary data by questionnaire survey. The monthly average of other economic factors has been collected from secondary sources. The distribution of land prices in BMA is studied by collecting market prices of land from reliable sources at all the study locations. The cumulative increase of land price from the year 2001 to 2015 is assessed. The monthly average of land price of all six location from the year 2001 to 2015 (180 sets) and simultaneous form of equations with known factor values are entered in Statistical Package of Social Science software for regression modeling. The data from the year 2001 to 2013 (156 sets) are used to develop the model and remaining data (24 sets) have been reserved for validating the obtained models. The influence of each factor on land price is derived by performing correlation analysis. The interaction effect among each factor is also performed to know the co-movement of factors. Regression and NN equations for all locations and a common model for BMA are developed with a minimum error level and the models are validated with the available land price data of 2014 and 2015. The models are evaluated by standard tests to examine their acceptable level and the tested models are used to forecast the land price for the forthcoming five years from 2016 to 2020.

V. ANALYSIS AND MODELING

A. Data collection

Primary data has been collected through interviews and personal visits to the various companies to know the present situation of the market and the secondary data is collected mainly through various newspapers, magazines, Internet and Reserve Bank of India review. The data between January 2001 and December 2015 are used in the analysis. Regression analysis is the statistical technique in which observational data are modeled by a function, which is a nonlinear combination of the model parameters and depends on one or more independent variables. NN has computational capabilities and is suitable to model the complicated mapping relationships. NN is a computing system made up of number of simple and highly interconnected processing elements which process information by its dynamic state response to external inputs. NN can be described both as mathematical and computational models for non-linear function approximation.

B. Multiple Regression technique

Regression analysis is widely used for prediction and forecasting. If more independent variables are added, it is able to determine an estimating equation that describes the relationship with greater accuracy. Multiple regressions look at each individual independent variable and test whether it contributes significantly to the way the regression describes the data. The general multiple regression equation is shown in Equation 1

$$Y = a + b1x1 + b2x2 + \ldots\ldots + bnxn \quad [1]$$

Where, Y = Estimated value corresponding to the dependent variable

a = y intercept

x1, x2…xn = values of n independent variable

Here, x1=Guideline value (Rs), x2=Population, x3=BSE Index, x4=NSE Index, x5=Gross Domestic Product (%), x6=Inflation (%), x7=Crude oil price per barrel ($), x8=Gold price per gram (Rs), x9=Silver price per gram (Rs), x10=Dollar equivalence (Rs), x11=Cost of construction per Square foot (Rs), x12=Home loan interest (%) and x13=Time (Year & Month)

b1, b2…bn = Slopes associated with x1, x2…xn respectively.

C. Neural Network Technique

NN is a computational technology from the artificial intelligence discipline whose architecture emulates the network of nerve cells in the human brain. A NN is a parallel distributed information-processing structure consisting of processing elements (PEs) which contains local memory. The approach presents the application of NN for modeling the land price trend with the support of economic and social factors. NN model is constructed with 13 indicators that are PEs with one bias node as input. All the input values are normalized using the MinMax table. Initially 180 sets of exemplars are generated as monthly basis from the year 2001 to 2015 for thirteen parameters as input and unit land price as output parameter.

The NN architecture, used in this study, is a multilayer feed forward network. Levenberg – Marquardt algorithm is used for training in multilayer NN. A five layered BPN has been developed with three hidden layers and one output layer. The architecture which provides the best fit for the data is the networks with three hidden layers and an output layer. The neurons in the hidden layers are 20, 13, 13 respectively and one neuron in the output layer. The learning and momentum parameters are 0.6 and 0.9 respectively and error convergence to fall below 0.01%. Tan sigmoid is the activation function chosen for hidden layers and pure linear is the function for output layer which are the real time values. The network is efficiently trained with 180 exemplars and the weights are properly updated. In order to implement the trained network for land price validation and forecasting the updated weights are copied from NN tool box as the weights of BPN. The weights are obtained in layers as input to first hidden layer, first to second hidden layer and second to third hidden layer and with bias values. The 24 exemplars are used to validate the network for the years 2014 and 2015 and 60 exemplars of 2016 and 2020 are used for forecasting the land price for which the trained network runs again.

VI. RESULTS AND DISCUSSION

A. Interaction of Influencing Factors

To measure the magnitude of linear relationship of land price (Y) on individual factor (X), correlation analysis is performed. The interaction of all the selected factors on land price is analyzed and inferred that other than

Table 3 Interactions of the selected factors on land price

Factors	Hebbal	Marthahalli	Jigani	Kengeri	Koramangala	Devanahalli	BMA
GLV	0.9	0.7	0.9	0.9	0.85	0.9	0.9
Pop	0.9	0.7	0.9	0.9	0.9	0.9	0.9
Time	0.9	0.8	0.9	0.9	0.9	0.9	0.9
BSE	0.8	0.7	0.8	0.9	0.8	0.9	0.8
NSE	0.8	0.6	0.8	0.9	0.9	0.9	0.9
GDP	0.2	-0.3	0.3	-0.2	0.4	0.1	-0.3
Infla	0.2	0.1	0.6	0.4	0.2	0.6	0.4
Croil	0.9	0.6	0.7	0.8	0.8	0.9	0.7
Gold	0.9	0.6	0.8	0.9	0.9	0.9	0.9
Silver	0.8	0.6	0.8	0.9	0.9	0.9	0.9
Doll	0.1	0.6	0.2	0.6	0.3	0.3	0.7
CC	0.9	0.7	0.9	0.9	0.9	0.9	0.9
HL	-0.4	-0.5	-0.8	-0.7	-0.5	-0.8	-0.6

GDP, Inflation and interest rate on home loan all other factors show good closeness. Multiple regression analysis is performed with 95 % confidence level and 5 % error significance and the analysis explains the trend very closely with a R^2 ranges between 0.62 and 0.99.

B. Behaviour of land price in BMA

The market price is collected from the year 2001 to 2015 and the models for six study locations are derived using Multiple Regression and ANN. The models are validated for the years 2014 and 2015. The land price model for the entire BMA is developed using the details of data collected from all the six study locations and is given in the Equation 2. The land price performance using multiple regression and ANN models for the BMA is plotted in the Figure 3. The behaviour of actual land price goes well along with the NN prediction than regression. The factors are ranked based on their influence on the model is shown in the Figure 4.

Land Price per 5.5 cents of BMA = 109407052.127 + $0.056*x_1$ + $428.736*x_2$ + $43.645*x_3$ + $457.519*x_4$ - $66503.514*x_5$ - $24085.894*x_6$ + $6939.536*x_7$ - $259.484*x_8$ + $7370.394*x_9$ + $120747.566*x_{10}$ - $10290.173*x_{11}$+127413.176*x12-77798.091*x_{13} [2]

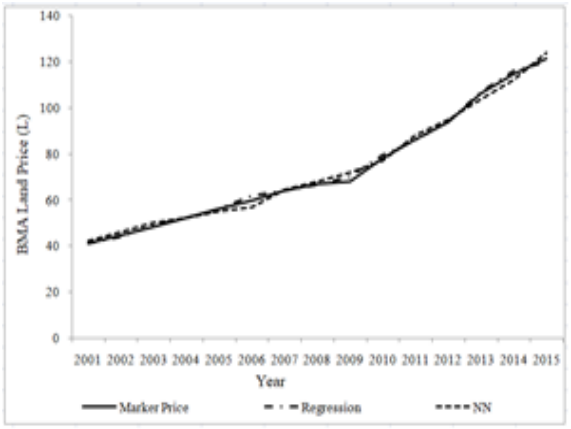

Fig.3. Validation of land price at BMA

C. Performance evaluation of the model

Accuracy of model is examined using standard measures, such as Chi-square test (χ^2) and Mean Absolute Percentage Error (MAPE). The consolidated results of model evaluation by Chi-Square Test and MAPE are tabulated in Table 4. Null hypothesis is assumed in the chi-square test that there is no significant difference between the observed and expected price of land. Theχ^2 values are obtained for all the six locations under study. The Table value of χ^2 is 18.05 with 5% level of significance. It can be seen that the values are much lower than the χ^2Table value, therefore the null hypothesis is accepted and proved that the models which are developed here are significant. In general a MAPE of 10% is considered very well, a MAPE in the range 20% - 30% or even higher is quite common. In this investigation it is observed that the MAPE values obtained from Regression is less than 12% and the same from ANN model is lesser than 4%. This observation reveals that both the models are found good for the prediction of land price in BMA.

D. Forecasting of Land Price in BMA

To forecast the future price of land, predicted values of factors are plugged into the model. All thirteen factors have been predicted by polynomial method for the period of 2016 and 2020 and plugged in the regression and neural network model, trained and the hypothetical data is allowed to test. The average increase in land price for the next five years between 2016 and 2020 is forecasted for all the selected six locations in BMA and the same is presented in Figure 5 and the forecasted land price of BMA is shown in Figure 6. The five

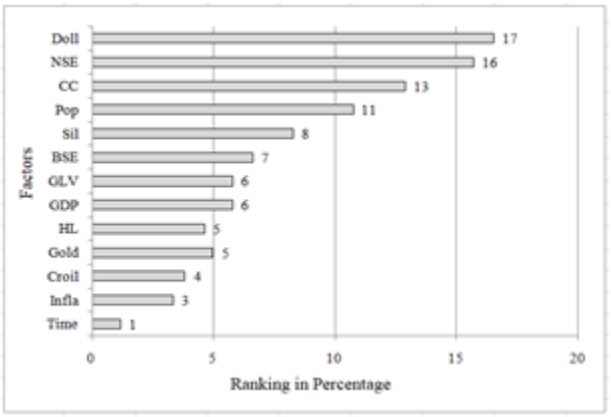

Fig.4 Ranking of factors by NN analysis on BMA land price

factors such as GLV, silver price, population in study area, cost of crude oil and unit cost of construction itself has more than 70% influence on the unit land price. The results show that a small increment in home loan interest will drag the land price and rise in remaining three factors further lifts the land price. The study areas such as Hebbal, Jigani and Devanahalli show the above scenarios effect well. Combination of 6% home loan, 5% inflation and GDP of 10% will have good control on the land price which may pulls down the price upto 5%. The reduction in cost of construction will pull down well the price of land such as 20% reduction in construction cost is expected to reduce the land price upto 10%). It is possible by using of alternate affordable materials and advanced cost effective construction methodologies will have better control on land price trend in the forth coming years.

Table 4 Land Price Model Evaluation

Locations	Chi-Square test		MAPE	
	Reg	NN	Reg	NN
Hebbal	2.62	1.79	8.67	1.42
Marthahalli	1.93	0.98	2.35	3.36
Jigani	0.84	1.72	1.92	2.36
Kengeri	3.31	4.63	12.03	2.76
Koramangala	1.69	1.39	1.96	0.97
Devanahalli	0.28	0.77	6.59	0.75

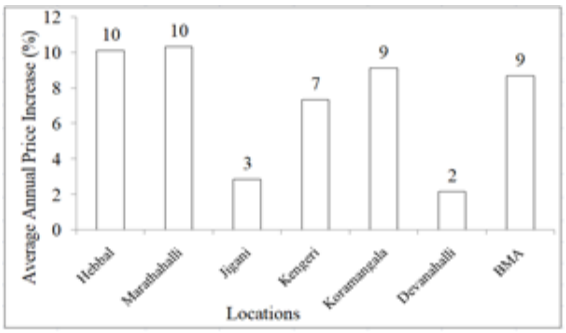

Fig. 5 Average annual increase of land price (2016-2020)

VI. CONCLUSION

Based on the analysis, modeling and forecasting of land price the following conclusions are drawn:

- The study reveals that economic factors influence land price more than the social factors.
- The interaction of the selected factors (X) on land price (Y) is analyzed. It is found that four factors viz. Dollar equivalence (17), National share index (16), the Unit cost of construction (13) and Population in the study area (11) have more positive effect on land price in BMA.
- Economic factors such as GDP (0.256), Inflation (0.435) and Dollar equivalence (0.665) show
- minimum correlation with land price of BMA.
- The forecast envisages that North (Hebbal 10%), East (Marthahalli 10%) zones of BMA are poised for annual growth in the forthcoming years compared to the South (Jigani 3% and Kengeri 7%) zone .
- The model forecasts the price rise of six study locations matches with the real price in 2020.
- Even though both the models are found to be well fit with the data set of the land price in all
- locations, the model using NN (correl 95%) shows better accuracy than the reggression model (correl 90%).
- The forecast predicts the average growth in the next five years will be an average of 8.3% in all the selected locations of BMA. The common BMA model explains the trend upto 88%.

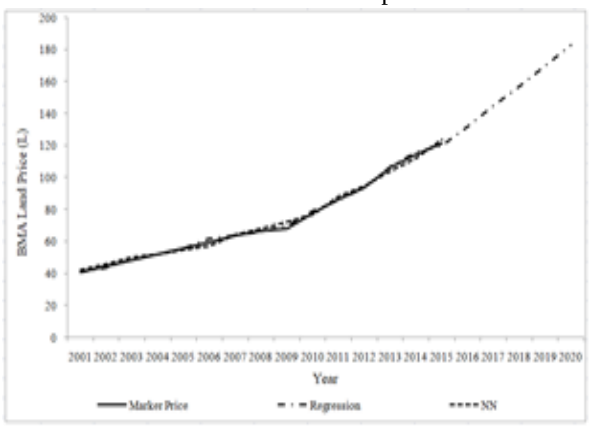

Fig. 6 Forecasted Land Price of BMA

The outcome of this study can be used in annual revision of guideline value of land which may add more revenue to the State Government while land transaction is made. This study will support the policy makers to relook the trend of the identified factors to have control on rise in the land price and to stabilize it. Since there is a greater need for a long-term data analysis about the land price, general land market behavior and spatial development, the results produced in this research may be of great use for Government and non-Government agencies which are involved in land administration.

REFERENCES

[1] Bengaluru City population 2011-2021, available at https://www.census2011.co.in/ census/city/ 448-bangalore.html.

[2] The Bangaluru Development Authority Act, 1976, available at https://www.indiacode.nic.in/handle/123456789/7903?view_type=browse&sam_handle=123456789/2485.

[3] Times of India (31/5/2014), "Bengakuru is second land price appreciation" available at https://timesofindia.indiatimes.com/business/india-business/Bengaluru-is-second-in-land-price-appreciation/articleshow/35811716.cms.

[4] Property Rates & Price Trends in Bengaluru – 2017, available at https://www.makaan.com/ price-trends/property-rates-for-buy-in-Bengaluru.

[5] Sampathkumar,V. and M.H. Santhi, 2010. Artificial neural network modeling of land price at sowcarpet in Chennai City. Int. J. Comput. Sci. Emerg. Technol., 1: 44-49.

[6] Urmila,S., 2010. Ports logistics and connectivity with inland container depot. Module No. 3, Institute of Rail Transport, Delhi, pp: 1-61.

[7] Greg Brown & Pat Reed. 2011. Values Compatibility Analysis: Using Public Participation Geographic Information Systems (PPGIS) for Decision Support in National Forest

Management. Appl. Spatial Analysis, DOI 10.1007/s12061-011-9072-x, Springer Science+Business Media B.V. 2011, http://www. landscapemap2. org/publications/ vca_article.pdf.

[8] Sampark Public Relations Pvt Ltd, 2011. Property prices in the Chennai region moved up by 15% in Q1-11 over Q1-10. http://www.afaqs.com/ news/company_briefs/?id= 50577_Property+ prices+in+the+Chennai+region+moved+up+by+ 15%+in+Q1-11+ over+Q1-10

[9] ICICI Property Services, 2012. Chennai residential real estate overview February 2012, available at http://www.icicihfc.com/ property _pdfs/chennairealestateoverview-february2012.pdf.

[10] ICICI Property Services, 2013. Chennai residential real estate overview April 2013, available at http://www.icicihfc.com/property _pdfs/Chennai-Real-Estate-2013.pdf.

[11] Times of India (28/09/2013), Bangalore property sales surged in 2012-13) Ref: https://t imesofindia. indiatimes. com/ business/india-business/bangalore- property-sales-surged-in-2012-13/ article show/ 23191442. cms.

[12] Todd BenDor, Douglas A. Shoemaker, Jean-Claude Thill, Monica A. Dorning and Ross K.Meentemeye 2014. A mixed-methods analysis of social-ecological feedbacks between urbanization and forest persistence, Published by the Resilience Alliance Ecology and Society 19(3): 3. http://dx.doi.org/10.5751/ ES-06508-190303. http://www. Ecologyand society.org/ vol19/iss3/art3/.