



## ORIGINAL ARTICLE

# Trend of land price at Pondicherry in India

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### Abstract

This study on land price trend in Pondicherry focuses on modeling and forecasting of land price in Pondicherry, India using multiple regression technique and neural network analysis. Four locations spread over Pondicherry area are selected at random for study. The monthly average values of the selected factors from the year 2000 to 2020 are considered to develop the models. Both multiple regression and neural network are validated with the market price for the upcoming years 2019 and 2020. After validation the models are used to forecast the landprice in Pondicherry area for the years between 2021 and 2024. Both the models are found to be well fit for the modeling of land price, however the model using Regression shows better accuracy. A careful examination of the result of forecasting brings to the lime light the surge in growth of land prices in the peak places of Pondicherry.

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## 1. Introduction

The analysis of land price pattern is considered appropriate in order to help urban planning decisions. The real estate market is a stochastic phenomenon that is inherently chaotic. Investors make choices based on industry dynamics in order to increase their profits. For their decision-making, developers want to hear about future developments. Estimate the land and property values with precision become necessary now. For trend of price study, modeling, and forecasting, a large amount of data which influences land price is needed.

The variables which determine the land price must be examined and their effect on land price to be assessed. A review of historical evidence showed that the land price had a nonlinear history. It can be concluded that maintaining a clear linear mathematical relationship for these time-series data is not feasible for forecasting. As a result, it became critical to develop a nonlinear model that can accurately match the data characteristics in order to evaluate and forecast future patterns.

Given the exponential development of the real estate market in Pondicherry, the study of trend and forecasting of land price using statistical method and neural network technique is a pressing necessity for all stake holders who are involved.

Pondicherry, also known as Puducherry, is the capital and largest city of the Union Territory of Puducherry, situated in Southern part of the Nation. The city is located in the Puducherry district along southeast coast, surrounded by the Tamil Nadu province, with which it shares the majority of its culture and language. The Pondicherry Municipality is divided into 42 wards. Wards 1 to 10 are located to the North of the district. Wards 11 to 19 are located in Boulevard Area, while the remainder of the wards is located in the southwest of the city centre. Pondicherry, India is located at 11.916064 latitude and 79.812325 longitudes.

## 2. Literature Review

There have been a considerable number of longitudinal surveys

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assessing land markets over the past decades. Wang, J and Tian, P (2005) [1] demonstrated the utility of a time-series regression model that used economic data to predict the price of CBD land in a moving economy. Anthony, H (2006) [2] conducted analysis on the residential real estate industry accounts for a significant amount of commercial production in the United Kingdom. Yegnanarayana, B (2006) [3] built a regression model which contained empty variables. Zhangming (2006) [4] used the Back Propagation (BP) NN to predict the real estate price index. The sigmoid feature was used by the BPN. Newell, G and Macfarlane, J (2006) [5] applied the Auto Regressive Integrated Moving Average (ARIMA) model to the price data from 1998 to 2006 and conducted a demonstrative analysis. To make the prediction, he used the existing model. The 2007 real estate price index Chennai's spatial evolution was meticulously recorded by Mason Gaffney (2009) [6]. Sampathkumar V et al (2015) [7] used Regression and NN technique to evaluate the trend of land price. The lists of significant attributes which influence the land price trend are shown in Table 1. Modeling is based on the relationship between the indicators and the price of land which is treated as dependent variable here. As per review the price of land, in Pondicherry is influenced by the various factors.

### 3. Study Areas

Pondicherry or Puducherry is a French colonial settlement in India until 1954. It is now a Union Territory town bounded by the Southeastern part of Tamil Nadu state. Its French legacy is preserved in its French Quarter, with tree-lined streets, mustard colored colonial villas and chic boutiques. A seaside promenade runs along the Bay of Bengal and passes several statues, including a 4m high Gandhi Memorial. Pondicherry has an area of 19.54 km<sup>2</sup>.

Table 1: List of independent variables

| Variables                                     | 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         |

and it is 3m elevated from mean sea level. According to the 2011 census of India, Pondicherry had a population of 244 lakhs. Pondicherry had an average literacy rate of 81%. The majority speak Tamil in Pondicherry. There is a community of French people and a number of French institutions such as the consulate of France in Pondicherry, the French Institute of Pondicherry and L'Alliance française. Pondicherry is

connected to Chennai via the East Coast Road through Mahabalipuram. There are daily bus services from several main stops from Chennai.

The Pondicherry Road Transport Corporation operates buses within the city and to Chennai and various places. The Tamil Nadu State Transport Corporation also operates bus services from Chennai to Pondicherry. Pondicherry is connected by train, to Chennai Delhi, Kolkata, and Mumbai, as well as other important cities such as Kanyakumari, Hyderabad, Nagpur, Bhubaneswar, Bengaluru, Visakhapatnam and Mangalore. Moreover, Villuram junction which is at a distance of 40 km is connected to several other Indian Cities. Pondicherry is a tourist destination in South India. The city has many colonial buildings, churches, temples and statues which, combined with the town planning and French style avenues in the old part of town, still preserve much of the colonial ambiance.

Kalapet or Kalapettai, is a town and enclave in the Union territory of Puducherry, India. It was annexed by the French in 1703 and has been a part of the Union territory ever since. It forms a part of the Pondicherry province of the Pondicherry district of the territory. Kalapet is the Northern most enclave of Pondicherry district and is surrounded on three sides by the Viluppuram district of Tamil Nadu while the Bay of Bengal bounds it on the East. It is cut off from the rest of Puducherry by the state of Tamil Nadu. It is located along the East Coast Road. Pillaichavadi is a small Village hamlet in Vanur Block in Villupuram District of Tamil Nadu State, India. It comes under Bommaiarpalayam Panchayath. It is located 36 KM towards East from District headquarters Viluppuram. 145 KM from State capital of Chennai. Pillaichavadi postal head office is at Kottakuppam. Pillaichavadi is surrounded by Mannadipet Block towards West, Pondicherry Block towards South, Villianur Block towards East and Marakkanam Block towards North. Pondicherry, Tindivanam, Viluppuram and Nellikuppam are the nearby Cities to Pillaichavadi. This Place is in the border of the Villupuram District and Pondicherry District. Pondicherry District Villianur is South towards this place. It is near to the Pondicherry State Border and near to Bay of Bengal. Saram is a Taluk under Pondicherry State. It is a revenue district which comes under the Tamilnadu postal circle of Chennai region. Ariyankuppam is also known by its former name Ariancoupom. It is a Town, Commune, Sub-Taluk, Assembly Constituency in the Union Territory of Puducherry, India. The streets in Ariyankuppam are straight and in grid forming, similar to Puducherry boulevard. Ariyankuppam was an ancient Indian fishing village which was formerly a major port dedicated to bead making and trading with Roman traders. Now Ariyankuppam is administrated as a town under Puducherry Union Territory of India. Ariyankuppam is 5 km away from Puducherry city. It is in between Puducherry and Cuddalore along NH-45A. One can reach Ariyankuppam by any local bus from Puducherry to Veerapattinam. The study locations in Pandicherry is shown in Fig. 1 and the geographical position of the study areas are shown in the Table 2.

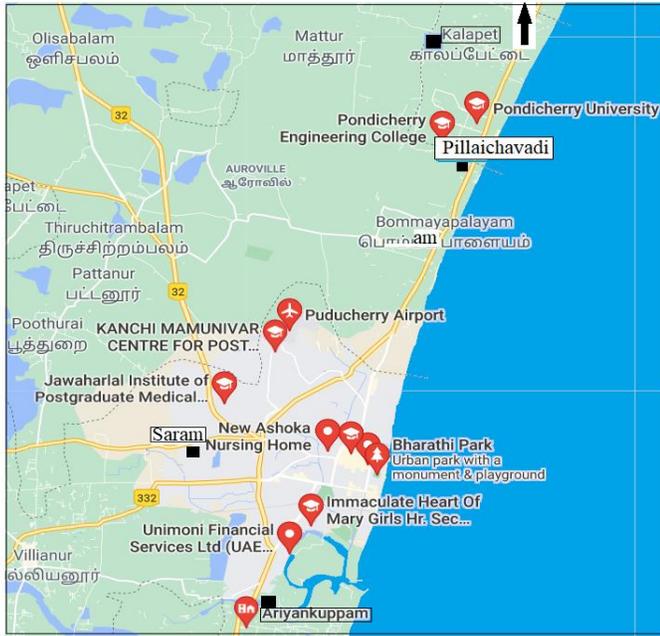


Figure 1: Location of Study Areas in Pondicherry

4. Analysis and Modeling of Land Price

4.1 Data Collection

Primary and secondary details are used in the analysis. Primary data wasgathered by interviews and personal visits to different firms in order to understand the current business condition, while secondary data was gathered from newspapers, journals, open sources and the Reserve Bank of India reviews. In this study, from January 2000 to December 2020 monthly data is included. The details are used to measure the efficiency of a property as a whole.

4.2 Multiple Regression technique

For forecasts, regression analysis is frequently used. Regression analysis is used to figure out which of the independent variables are relevant to the dependent variable and to investigate the types of relationships which exist. If there are more, as independent variables are introduced, an estimating equation will accurately define the relationship which can be determined. Multiple regression examines the independent variable to see how it has a major impact on the dependent variable and how the data is defined by the regression.

The general multiple regression equation is

$$Y = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n$$

Where, Y= Estimated value corresponding to the dependent variable

b0= y intercept,

x<sub>1</sub>, x<sub>2</sub>...x<sub>n</sub> = values of n independent variable and

b<sub>1</sub>, b<sub>2</sub>...b<sub>n</sub> = Slopes associated with x<sub>1</sub>, x<sub>2</sub>...x<sub>n</sub> respectively.

Table 2: Geographical position of the study areas in Pondicherry

| Location      | Latitude   | Longitude  |
|---------------|------------|------------|
| Pondicherry   | 11.9416° N | 79.8083° E |
| Kalapet       | 12.0370° N | 79.8552° E |
| Pillaichavadi | 12.0096° N | 79.8549° E |
| Saram         | 11.9408° N | 79.8121° E |
| Ariyankuppam  | 11.8958° N | 79.8046° E |

4.3 Neural Network Technique

Neural network (NN) is a computational framework based on knowledge of biological neural cells or neurons in the brain for its architecture and function. NNs are mathematical and computational models for nonlinear function approximation, data classification, clustering, and nonparametric regression, as well as simulations of the behavior of collections of model biological neurons (Kasiviswanathan K.S and Sudheer K.P, 2016) [8]. NN, which is known as artificial intelligence, is a paradigm that is supposed to resemble biological neural networks. The NN is a versatile mathematical structure capable of detecting complex non-linear relationships between input and output data sets. The key benefit of the NN methodology for price forecasting over traditional approaches is that it offers a standardized approach and reduces the time spent on model preparation. NN is a statistical model of human cognition or neural biology that has been generalized.

Initially 252 sets of exemplars are generated as monthly basis from the year 2000 to 2020 for 13 parameters (GDP, cost of crude oil, dollar equivalence, rate of inflation, gold and silver price, Mumbai and National Share Index, etc) as input and unit land price as output parameter. The NN architecture, used in this study, is a multilayer feedforward 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 is shown in Fig. 2. 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 228 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 toolbox 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 2019 and 2020 and 60 exemplars between 2021 and 2025 are used for forecasting the land price for which the trained network runs again.

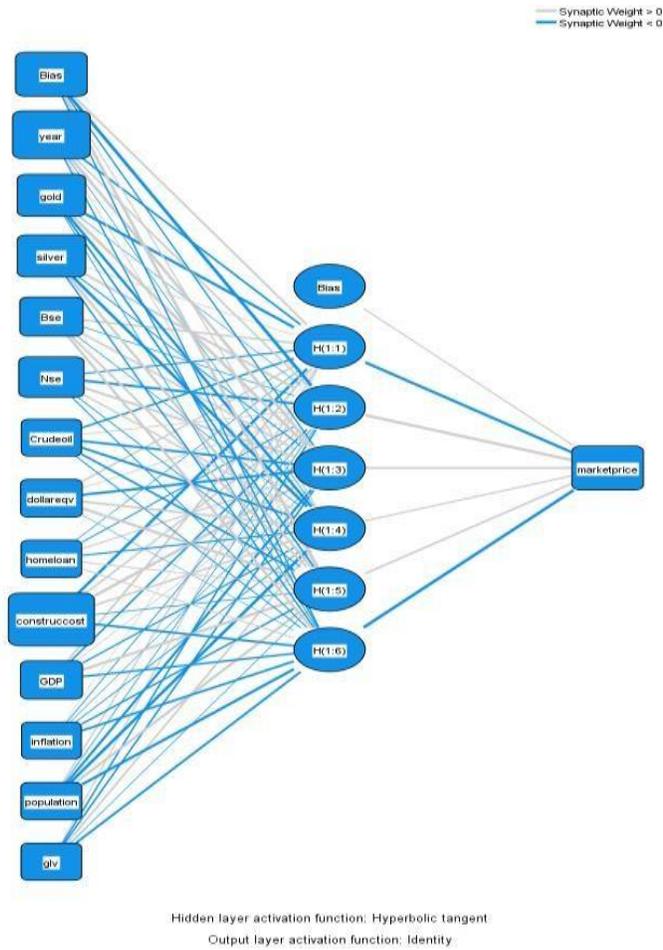


Figure 2: Neural Network Architecture for land price modeling

5. Results and Discussion

5.1 Interaction of Influencing Factors

To measure the magnitude of linear relationship of land price (Y) on individual factor (X), correlation analysis is performed. Correlation analysis is a statistical tool, which is used to determine the degree of which one variable is linearly related to another

The interaction effect of all the selected factors on land price is analyzed and is shown in Table 3. Other than Inflation, Dollar equivalence and home loan interest all factors show good closeness. Multiple regression analysis is performed with 95% confidence level and 5% error significance and the analysis is explaining the trend very closely with an R<sup>2</sup> ranges between 0.97 and 0.99.

$$\text{Market Price at Pondicherry} = 53790097.23 + 156.02 * x_1 - (8238.72 * x_2) - 0.263 * x_3 + (30.386 * x_4) + (11.224 * x_5) - (1824.115 * x_6) + (7667.66 * x_7) + (5729.664 * x_8) - (522.276 * x_9) + (9574.73 * x_{10}) - (26624.259 * x_{11}) - (0.374 * x_{12}) - (5.880 * x_{13}).$$

Here, x<sub>1</sub>=Time (Year & Month), x<sub>2</sub>=Gold price per gram (Rs),

x<sub>3</sub>=Silver price per gram (RS), x<sub>4</sub>=BSE Index, x<sub>5</sub>=NSE Index, x<sub>6</sub>=Inflation (%), x<sub>7</sub>=Crude oil price per barrel (Rs), x<sub>8</sub>=Dollar equivalence (Rs), x<sub>9</sub>=Gross Domestic Product (%), x<sub>10</sub>=Cost of construction per Square foot, x<sub>11</sub>=Home loan interest (%), x<sub>12</sub>=Population and x<sub>13</sub>=Guideline value (Rs).

The land price performance using multiple regression and ANN models for Pondicherry is plotted in the Fig. 3. It can be seen that the behaviour of actual land price goes well along with the NN prediction than regression. Regression model values are very close to the real market price of land in Pondicherry and the divisions in price are shown a normal distribution which is shown in Fig. 4. A histogram is a graphical representation of statistics that represents the distribution of data visually. A normalized histogram may also be used to represent relative frequencies. Population, Unit cost of construction and Mumbai and National share index alone has more than 65% influences on Pondicherry model. The factors are ranked based on their influence in the model is shown in the Fig. 5.

Table.3: Interaction of the selected factors on land price

| Factors | Kalapet | Pillaichavadi | Saram | Ariyankuppam | Pondicherry |
|---------|---------|---------------|-------|--------------|-------------|
| Time    | 0.98    | 0.96          | 0.98  | 0.97         | 0.98        |
| Gold    | 0.96    | 0.92          | 0.96  | 0.92         | 0.95        |
| Silver  | 0.93    | 0.93          | 0.94  | 0.94         | 0.94        |
| BSE     | 0.95    | 0.96          | 0.96  | 0.97         | 0.96        |
| NSE     | 0.95    | 0.96          | 0.96  | 0.97         | 0.96        |
| Croil   | 0.62    | 0.50          | 0.57  | 0.49         | 0.55        |
| Dol     | 0.89    | 0.93          | 0.90  | 0.93         | 0.91        |
| HL      | -0.36   | -0.36         | -0.40 | -0.42        | -0.40       |
| CC      | 0.98    | 0.99          | 0.99  | 0.99         | 0.99        |
| GDP     | -0.10   | -0.14         | -0.13 | -0.10        | -0.12       |
| Infla   | 0.03    | -0.13         | -0.01 | -0.12        | -0.04       |
| Pop     | 0.97    | 0.97          | 0.97  | 0.95         | 0.99        |
| GLV     | 0.89    | 0.95          | 0.94  | 0.96         | 0.98        |

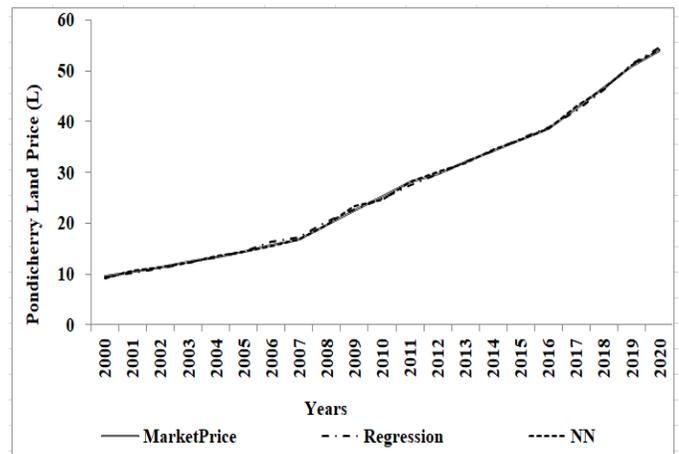


Figure 3: Validation of land price at Pondicherry

5.2 Forecasting of Land Price in Pondicherry

To forecast the future price of land, predicted values of all selected factors are plugged into the model. All the economic factors are predicted by polynomial method for the period between 2021 and 2025. The interest on home loan is expected to drag by 2025 and it is projected as 8.2% in the year 2025. Construction cost is believed to rise by 5.5% annually. The GDP is expected to fall by 1% annually and the inflation will remain at comfort level of 6%. Based on the past trends, the Consumption of precious metals, gold and silver show a remarkable increase in price of more than 18% within next five years. As far as increase in stock is concerned, the projected increase is 26% and 27% on BSE and NSE respectively to reflect a progressively healthy economy. An annual increase in population in study areas are assumed as per development authority's draft. These above assumptions on the factors are 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 5 years is forecasted for the selected four locations in Pondicherry and is presented in Fig. 6 and the forecasted land price of Pondicherry is shown in Fig. 7.

The five factors such as time, BSE Index, NSE Index, cost of crude oil and dollar equivalence is having more influence on the unit land price, which is the output. Independent and combined effect of factors such as home loan interest, inflation, GDP and cost of construction are tested as different scenarios on the regression models of all the areas such as home loan interest assumed at an acceptable level of 8%, inflation at a comfortable zone of 4-5%, GDP at a better range between 8 and 9% and cost of construction at a tolerable level of Rs 1900 to 2200 per one square foot area. 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. A drop in building sale prices would pull down the price of land. To keep adequate control on land prices from increasing in the future, our policy focus should be on reducing construction cost by reducing material costs, using alternative affordable materials and by using advanced cost effective design methodologies on a broad scale.

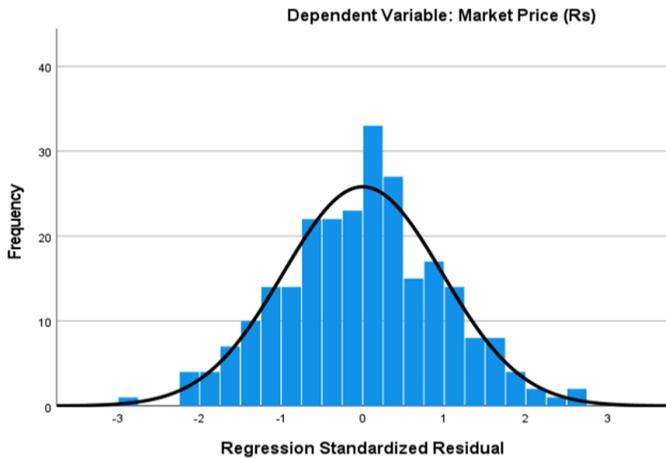


Figure 4: Regression Residual Histogram of Pondicherry land price

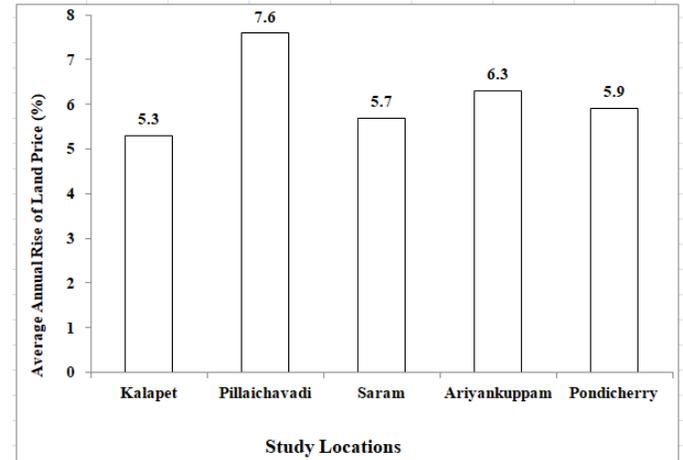


Figure 6: Average annual increase of land price (2021-2025)

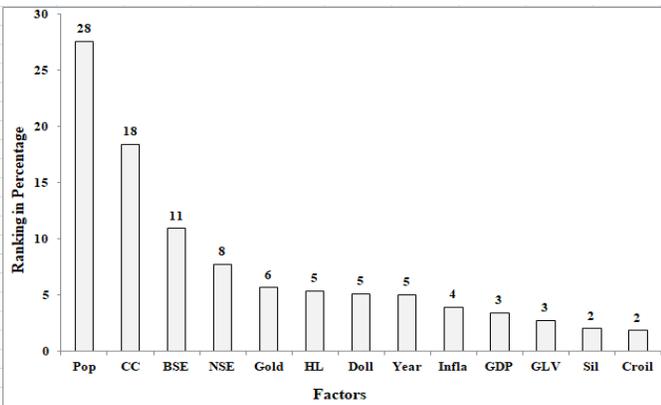


Figure 5: Ranking of factors by NN analysis on Pondicherry land price

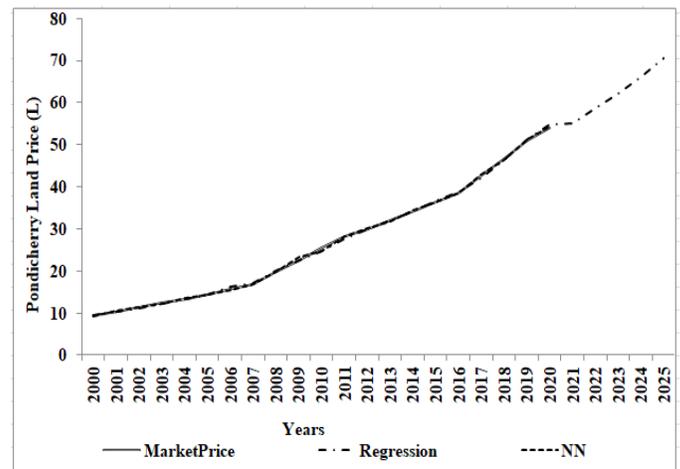


Figure 7: Forecasted land price at Pondicherry

## 6. Conclusions

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

- The study shows that the land price influenced more by economic factors than social Factor.
- The factors such as population, construction cost per unit area, share index and metal cost alone have more than 70% effect on land price in Pondicherry.
- In the analysis, the factors such as time, share index, oil price and dollar equivalence show positive correlation with unit land price.
- In this analysis, the predictive and forecasting ability of regression and NN techniques on land price is compared. Despite the fact that both models are found to be well matched with the data set of land price modeling and forecasting in all locations, the model based on regression shows higher accuracy.

A common land price model for Pondicherry is developed with 90% closeness with the real market price.

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