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## POPULATION GROWTH MODEL FOR NASIK DISTRICT

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### ABSTRACT:

*A complex trend of population change can be modeled with suitable curves and from the models the future values can be estimated with great accuracy. Population with increasing trend is the key factor restricting development of the region. On the other hand slowing-down population growth is related to improving population quality, developing human resources, and properly solving the issue of population with overall consideration have become the key factor promoting district's economic and social development, scientific and feasible prediction of the population growth trend is of great significance. First based on figures presented in the historical data, this paper first uses Malthus' model of population growth as reference and establishes the mathematical model which behaves like linear model up to certain time period, then as time progresses because of awareness about family planning the curve change to exponential growth model, and from two decades the growth is constantly decreasing and shape of the curve becomes logistic. By considering data Nasik population from 1901 till date size and by adopting the methods of regression and fitting; finally we find out of two exponential growth model, In the present study, attempt has been made to analyse the increasing trend of population with two different models of Nasik district of Maharashtra state.*

*Keywords: Population, Regression Analysis, Exponential Growth Model*

### INTRODUCTION:

Nasik district, located in North West Maharashtra, is one of the fastest developing regions of the Maharashtra state. During the Mogul rule, it was known as Gulshanabad and in 1751, it was renamed as Nasik. The total area of Nasik district is 15698 sq kms, the population of Nasik district as per the census of 1961 is 18,55,246. The first official enumeration of the district population was made in the 1872 Census according to which the total population of the district was 734,386 souls or ninety to the square mile. There was much of an early element in this population. Considerable changes have taken place from time to time both as regards the size as well as the character of the population since then. Table No.1 shows the growth and the variation in population of the district from decade to decade.

### STUDY AREA:

The Nasik district of Maharashtra state has been selected for the proposed work. The extent of the district lies in 19° 35'N and 20° 52' N latitude 73° 16'E and 74° 56' E longitude, with an area of 15,698 sq kms (6,015 sq. miles) and it rank third in state with 5.04% area. Nashik district has a population of 49,93,796 as per the census of 2001. Nasik district is Rhomboidal in shape with the longer diagonal of about 170 km. from south-west to north-east and an extreme breadth of about 120 km. from north to south, Nasik district lies in the north-west part of the state.

**AIMS AND OBJECTIVES:** Present study intends the following objectives-

- To understand the changes in Population Growth Rate of Nasik district.

- To fit various population curves to the data and compare the accuracy of the models.
- To estimate the population for future time periods.

**SOURCES OF DATA:**

For present study data regarding population have been collected from socioeconomic surveys, population surveys and also abstracts published by Indian Institute of Population Science, Mumbai. The information of Nasik district have been collected from District Census Handbook

**METHODOLOGY:**

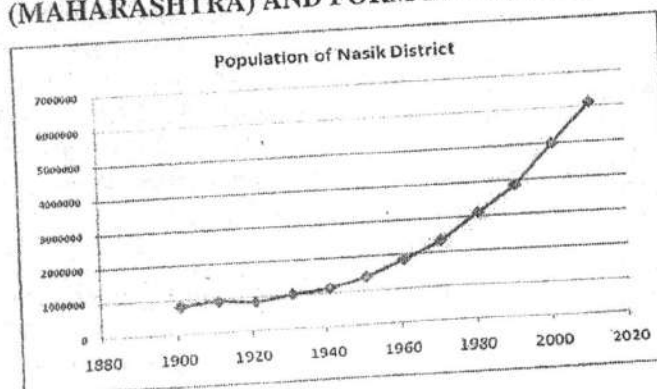
The proposed work aims at investigating the best model of fit that is mathematical model, it will help to estimate the accurate population figures for future planning of city and management of resources. Not only has this but also minimized the disparities in socio economic development within the study area with respect to development of infrastructure.

**GROWTH AND VARIATION IN POPULATION, NASIK DISTRICT, 1901-2011**

Year	Population	Decade variation	Rate of variation
1901	823,080	....	....
1911	915,698	+ 92,618	+ 11.25%
1921	845,783	- 69,915	-7.64%
1931	1,009,583	+ 163,800	+ 19.37%
1941	1,127,597	+ 118,014	+ 11.69%
1951	1,429,916	+ 302,319	+ 26.81%
1961	1,855,246	+ 425,330	+ 29.75%
1971	23,69,221	+ 513975	+ 27.70%
1981	3110287	+ 741066	+31.28%
1991	3851352	+ 741065	+ 23.83%
2001	4993796	+ 1142444	+ 29.66%
2011	6109052	+ 1115256	+ 22.33%

Source: District Census Handbook, Nashik District, 2001

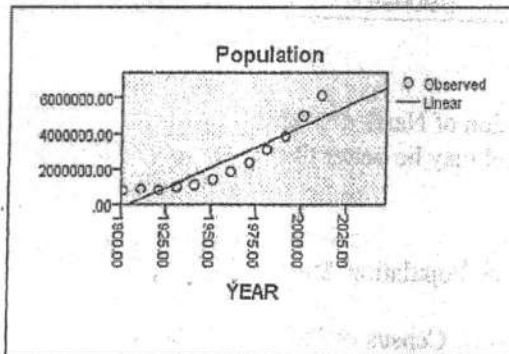
**GRAPH 1: EXHIBITS TOTAL POPULATION NASHIK DISTRICT (MAHARASHTRA) AND FORM 1901 TO 2011**



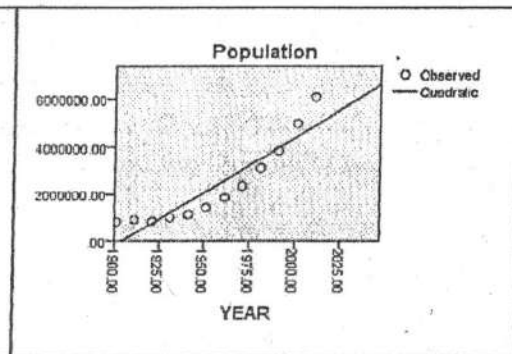
It can be seen that except for the decade of 1911-21 when the severe influenza epidemic took a heavy toll of life, the population of the district has increased all along, although not at a uniform rate. During the decades of 1941-51 and 1951-61 it increased proportionately at higher rates, viz., by 26.81 per cent and 29.75 per cent, respectively. This was due partly to the growth of Nasik and Malegaon cities and partly to the control of epidemic and other diseases, especially after 1950. The 1951-61 decade variation for the district then constantly increasing with steady rate.

REGRESSION MODELS USING SPSS

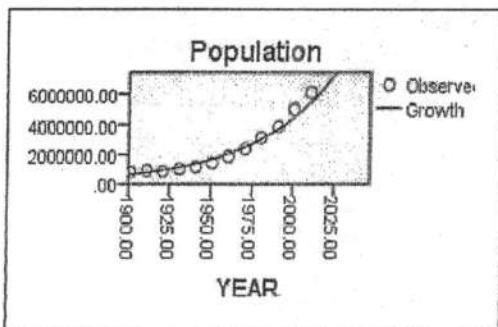
Model	Coefficients	R	R <sup>2</sup>	Equation	R S S
Linear Coefficient	45636.631	.923	.852	Y = A + BX	5.18488E+12
Constant	-86895354.285				
Quadratic X <sup>2</sup> Coefficient	011.703	.926	.857	Y= A + BX + CX <sup>2</sup>	4.99417E+12
Constant	-42417984.721				
Exponential Coefficient	0.020	.979	.959	Y= A X <sup>B</sup>	9.90331E+11
Constant	4.209E-11				
Exponential Coefficient Growth	0.020	.979	.959	Yt = Y0 e r X	9.90331E+11
Constant	-23.891				
Logistic Coefficient	0.981	.979	.959	Yt = Y0 e rX / [1+(e <sup>rX</sup> - 1)(Y0 / K)]	9.90331E+11
Constant	23757014770.611				



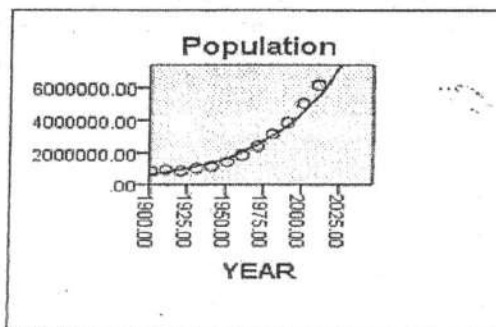
$$Y_x = -86895354.285 + 45636.631 \cdot X$$

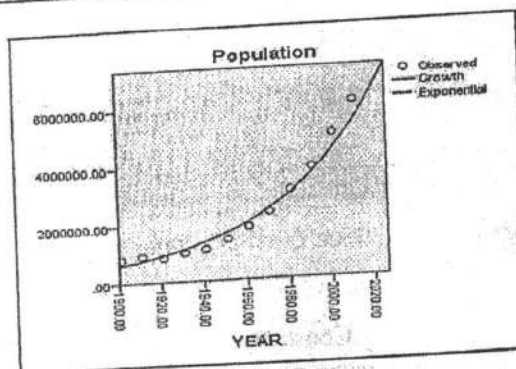
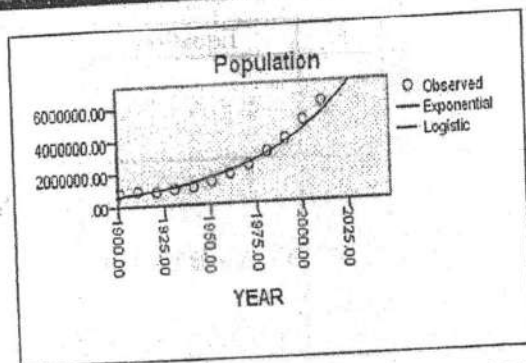


$$Y_x = -42417984.721 + 011.703 \cdot X^2$$



$$Y_x = 4.209E-11 \cdot 0.020^x$$





$$\text{Log}(Y_x) = -23.891 + 0.020 \cdot X$$

The data shows linear pattern up to 1961, after that point the growth shows exponential pattern. Because of government efforts and change in the attitude of people towards family planning the curve changes its convexity and the curve become exponential growth model. Now it is point of saturation and we will expect constant population that is number of births and number of deaths will be equal that is represented by logistic curve. (if the number of births and deaths per person per year were to remain at current levels) By comparing residual sum of squares we can see that Exponential growth model is of best fit. Residual Sum of Squares for Exponential growth model is minimum therefore the model is used to predict population of Nasik as follows.

		Quadratic	Exponential		
Year	Linear Prediction	Prediction	Growth	Exponential	Logistic
2015	5062456.	5097772.	5895633	5895633	5895633
2016	5108093.	5144946.	6012288	6012288	6012288
2020	5290639.	5333875.	6502452	6502452	6502452
2025	5518823.	5570563.	7171729	7171729	7171729
2030	5747006.s	5807836.	7909893	7909893	7909893

#### CONCLUSION:

1. The exponential growth model fits the population of Nasik district.
2. For the year 1991, the logistic regression model may be better than exponential growth model.

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