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An Overview of Population Growth Trends of Nepal

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ABSTRACT

This paper aims to estimate population growth rates of Nepal and also to estimate required time period for doubling population. For this, arithmetic, geometric and exponential growth models are applied. The data are taken from the recent national censuses of Nepal. Population growth trends were 2.10% in 1971, 2.60% in 1981, 2.10% in 1991, 2.25% in 2001 and 1.35% annually in 2011. The trends of urban populations were about 4% in 1971, 6% in 1981, 9% in 1991, 14% in 2001 and 17% in 2011. The population density rose from 79 in 1971 to 181 in 2011. Urban growth rate was 7% whereas it was 2% for rural areas. The population change was found to be 40% in urban whereas 11% in rural areas during 2001-2011. However, overall change was found to be 14% during 2001-2011. The estimated growth rates were found to be 1.44%, 1.35% and 1.35% by using arithmetic, geometric and exponential respectively. The estimated time period for doubling populations was found to be 67 year by arithmetic growth model and 50 years by geometric and exponential growth model. The findings of this paper may help policy-makers and planners for designing population policy of Nepal.

Key words: Mathematical models, geometric growth rate, exponential growth rate, doubling population

INTRODUCTION

Population growth is the change in a population over time, and can be quantified as the change in the number of individuals. Human population is multi-disciplinary in nature, which provides enlightening insights into changes in population structure and behavior, pinpointing causal relationships and refining explanations (Aryal, 2008). The demographic changes indicate not only the changes in population size but also the changes in its composition, distribution and the related development process (Aryal, 2013).

Population projections have been derived in stability condition under various paths of fertility reduction (Pathak & Ram, 1985; Yadava, 1993). The population growth is most rapid in the least developed parts of the world as compared to that of the developed parts. The size of the population does not depend only on the way of reduction in fertility but also as the several other existing parameters of the population (Yadava, 1993). Policy-makers, planners, social scientists and researchers are engaged in searching the solution of complex problems like hunger, poverty, illiteracy and other socio-economic questions facing the human beings caused due to high rate of population growth in most of the developing and developed countries while most of the third world countries are facing problems due to unchangeable conditions like huge population, a limited amount of arable land and natural resources, low level of literacy, a large percentage of unskilled/dependent manpower, agri-based economy, land locked and largely rural society, etc.

Nepal is a mountainous Himalayan country, having population density of 181-persons/square kilometer of area 147,181 km^2. The economy of the country is overwhelmingly rural and agriculture-based. The total population is now 26.5 million in 2011 and it is increasing at the rate of 1.35 per cent annually. The trends of population growth rates increased from 2.1 in 1971 to 2.6 in 1981 and then decreased to 2.1 in 1991 and then it again increased to 2.3 in 2001. The inter-census population growth rate again decreased to 1.35 in 2011. There have been about 60 per cent increase in population from 11.6 million in 1971 to 18.5 million in 1991 and in last one decade it increased by about 27 per cent from 18.5 million in 1991 to 23.2 million in 2001. The increment was over 14 % during 2001-2011. Nepal still has a low level of urbanization compared to other developing countries and her number of urban centers increased from 16 in 1971, 23 in 1981, 33 in 1991 and to 58 in 2001, and in 2011 more 41 municipalities were introduced. Due to such increasing level of urbanization, the volume of migration is also increasing both within and outside of the country, which really affects the total population of Nepal.

Majority of the Gross Domestic Products come from the service and non-agricultural sectors and the per capita Gross National Income is not so sound as compared to that of the developed countries. The per capita income of the people has still been not much to maintain way of life smoothly, however, the Economic Survey of 2069/70 reported the per capita income is around 700US$ (MoF, 2013). One fourth of the population in Nepal lives below absolute poverty line. Nepal has experienced a very high unemployment rate and underemployment rate that compelled people to remain under the vicious cycles of poverty that resulted to involve in the process of migration to other places within and outside the country for looking better opportunities of livelihood (Aryal, 2013, CBS, 2011).

Although, economic growth of the country has not improved markedly over time to overtake the growth rate of population. It is widely recognized that migration is a complex phenomenon involving a number of social, economic, cultural, political and behavioral factors (Aryal, 2008). The rising growth of population is a principal problem of socio-economic development as identified by most of the developing countries. Several population growth models have been developed for the study of the population change in different populations (Bogue, 1969; Bongaarts & Bulatao, 1999; Keyfitz, 1977; Polard, 1973; Kulkarni, 1976; Yadav, 1993; Yadava, 1985). In this context, this paper attempts to apply simple arithmetic, geometric and exponential growth models to study the trends of population growth of Nepal. For this purpose, the data are taken from national censuses of 2001 and 2011 (CBS, 2011).

MATERIALS AND METHODS

Data

The data are used from the population censuses of Nepal (2001 & 2011). Different population growth models are applied to study the population growth of a country. In brief the descriptions of the used models are given below.

Mathematical models

Arithmetic growth model

In arithmetic growth rate, it is assumed that a population is increased arithmetically with a constant number of people in each period, which is a linear type of model that gives the rate of change of the population. The model is given below.

$$P_t = P_0(1+r)^t$$

where P_t =population at the current year or recent year

P_0 = population at the base year or previous year

t= number of intervals between P_0 and P_t.

r = the growth rate of the population

Geometric growth model

In geometric growth model, it is assumed that a geometric progression is the progression in which the population increases or decreases at a same rate over each unit of time i.e. a year. However, in arithmetic progression, the growth assumed to be constant over each unit of time or a year. Thus in geometric growth, entails ever larger increment of population for each unit. The mathematical expression is given below.

$$P_t = P_0(1+rt)$$

where P_t =population at the current year or recent year

P_0 = population at the base year or previous year

t= number of intervals between P_0 and P_t.

r = the growth rate of the population

Exponential growth model

In exponential growth model, it is assumed that the exponential growth refers to the condition that it compounds population increment or decrement continuously at every instant of time. In other word, if a population increases with a constant rate of growth, it is known as exponential growth where the size of population increases without any limit if the growth rate is positive and decreases steadily if it is negative. The mathematical expression is given below.

$$P_t = P_0 e^r$$

where P_t=population at the current year or recent year

P_0=population at the base year or previous year

t= number of intervals between P_0 and P_t.

r = the growth rate of the population

e=exponential and it constant value is equal to 2.71828.

RESULTS AND DISCUSSION

The trends of populations, growth rates, population density and percentage change in urban population were presented in Table 1. Population growth rates were 2.1 in 1971, 2.6 in 1981 and again it was 2.1 in 1991, 2.25 in 2001 and it came down to 1.35 per cent annually in 2011. The urban population increases rapidly over time where it was 4% population were residing in urban areas in 1971, 6.4% in 1981, 9.2% in 1991, 14.2% in 2001 and 17% in 2011. The population density rose largely where it was 79 in 1971 increased to 181 in 2011.

Table 1. Nepal's population growth rate, density and percentage of urban population

Population measures	Censuses Year				
	1971	1981	1991	2001	2011
Population (millions)	11.6	15.0	18.5	23.2	26.5
Growth rate (r)	2.1	2.6	2.1	2.25	1.35
Density(pop./km^2)	79	102	126	158	181
% of urban population	4.0	6.4	9.2	14.2	17.0
Source- National population censuses, 2001 and 2011					

Table 2. Population change and growth by eco-development region

Characteristics	2001		2011		Population change	% change
	Total population	Growth Rate	Total population	Growth Rate		
Urban	3227879	6.65	4525781	3.38	1297902	40.21
Rural	19923544	1.72	22095022	1.03	2171478	10.90
Mountain	1687859	1.57	1795354	0.62	107495	6.37
Hills	10251111	1.97	11475001	1.13	1223890	11.94
Tarai	11212453	2.62	13350454	1.75	2138001	19.07
Eastern	5344476	1.84	5834182	0.88	487706	9.16
Central	8031629	2.61	9713702	1.90	1682073	20.94
Western	4571013	1.90	4945190	0.79	374177	8.19
Mid-western	3012975	2.26	3584386	1.74	571411	18.97
Far western	2191330	2.26	2543349	1.49	352019	16.06
Nepal	23151423	2.25	26494504	1.35	3343081	14.44
Source- National population censuses, 2001 and 2011						

The differentials of population structures are presented in Table 1. The population change over time is largely varied in relation to the characteristics of population. It was noticed that the population changes over time was higher among the population who residing urban and developed areas as compared to that of the rural and backward regions. The growth rate was higher in urban and better off regions as compared to that of the backward and rural areas. Urban growth rate was accounted to be about 7% and rural growth rate was about 2% in 2001. The rates respectively were 3.4% and 1% for urban and rural in 2011. However, the change was 40% in urban and 11% in rural areas during 2001-2011 and the growth rates were 2.25% in 2001 and 1.35% in 2011. The overall change was about 14% during 2001-2011 and the population change was larger in urban areas followed by Central Region, Tarai belt, Mid-western, Far-western, Hills, Eastern and Western Nepal.

Table 3. Highest and lowest population districts of Nepal in 2011

Highest population			Lowest population			
Districts	**Population**	**% of total population**	**Districts**	**Population**	**% of total population**	**% change**
Kathmandu	1740977	6.54	Manang	6557	0.02	40.21
Morang	964709	3.62	Mustang	13799	0.15	10.90
Rupandehi	886706	3.33	Dolpa	36701	0.14	6.37
Jhapa	810636	3.05	Rasuwa	43798	0.16	11.94
Kailali	770279	2.89	Humla	51008	0.19	19.07
Source- National population censuses, 2001 and 2011						

The districts level analysis shows overwhelmingly varied population structures where Kathmandu, Morang, Rupandehi, Jhapa and Kailali districts are the five highest population districts whereas Manang, Mustang, Dolpa, Rasuwa and Humla are the five lowest population districts of Nepal in the national census 2011 (Table 3).

For computing arithmetic growth rate, we can solve the equation of $P_t = P_0(1 + rt)$, then

$$P_t = P_0 + P_0 r t$$

or $P_t - P_0 + = P_0 r t$

or $\frac{P_t - P_0}{P_0 t} = r$

or $r = \frac{P_t - P_0}{P_0 t}$

The growth rate is expressed in terms of per cent and it is given below.

$$r = \frac{P_t - P_0}{P_0 t} \times 100$$

Thus the arithmetic growth rate during 2001 to 2011 is computed by using above formula. The censuses data are- P_t=P_{2011}=26494504 in 2011 and P_0=P=23151423 in 2001 and t=2011-2001=10 years.

$$r = \frac{P_{2011} - P_{2001}}{P_{2001} \times t} \times 100 = \frac{26494504 - 23151423}{23151423 \times 10} \times 100 = 1.44$$

per cent per annum.

For computing geometric growth rate, we can solve the equation of $P_t = P_0(1+r)^t$, then the growth rate of the population during 2001 to 2011 is computed as below.

$$r = \left[Anti\log\left(\frac{\log\left(\frac{P_t}{P_0}\right)}{t} \right) - 1 \right] \times 100 = \left[Anti\log\left(\frac{\log\left(\frac{P_{2011}}{P_{2001}}\right)}{(2011-2001)} \right) - 1 \right] \times 100$$

$$= \left[Anti\log\left(\frac{\log\left(\frac{26494504}{23151423}\right)}{10} \right) - 1 \times 100 \right]$$

$= (1.01406 - 1) \times 100 = 0.0135795 \times 100 = 1.349$ per cent per annum.

Similarly for computing exponential growth rate, we can solve the equation of $P_t = P_0 e^t$, then the growth rate during 2001 to 2011 is computed as below.

$$r = \frac{\log\left(\frac{P_t}{P_0}\right)}{t \log e} \times 100 = \frac{\log\left(\frac{26494504}{23151423}\right)}{10 \times \log e} \times 100$$

$= 0.013488 \times 100 = 1.35$ per cent per annum.

Computation of population doubling period

The time required for doubling the population is an important index for analyzing the rapid population growth of a country. This index of population doubling time gives up to date information of the population growth. The question is that how many year it will take to double in the size of the population if an annual rate of population increase is continued over a time. It is therefore, population doubling period will be computed using population models. For computing population doubling period, we can use arithmetic, geometric and exponential growth models. In brief, the procedures are given below.

Population doubling in case of arithmetic growth rate- The population doubling period can be computed as: $P_t = P_0(1 + rt)$, where notations have their usual meanings.

The population doubling period imply that P_t =$2P_0$ and on solving we get

$$P_t = P_0(1+rt) \Rightarrow 2P_0 = P_0(1+rt) \Rightarrow 2 = (1+rt)$$

or $t = \frac{1}{r}$

The time required for doubling the population in arithmetic growth rate of 0.01444 per annum of Nepal is as $t = \frac{1}{r} = \frac{1}{0.01444} = 66.67$ years time

Population doubling in case of geometric growth rate- the time required for doubling the population for the geometric growth rate of 0.0136 per annum of Nepal is computed as,

$$= \frac{\log 2}{\log(1+r)} = \frac{\log 2}{\log(1+0.0136)} = 49.51 \text{ ears of time.}$$

Population doubling in case of exponential growth rate- the time required for doubling the population for the exponential growth rate of 0.013488 per annum of Nepal is obtained as, $= \frac{\log 2}{r \log e} = \frac{\log 2}{0.013488 \times \log e} =$ 49.65 years of time.

Table 4. The growth rates and time required to double the population of the country

Models	Rate (%)	Time required to double the population (in years)
Arithmetic	1.444	66.67
Geometric	1.349	49.51
Exponential	1.350	49.65

Estimated population growth rates and time required for doubling the populations are presented in Table 4. The growth rates were estimated to be 1.444%, 1.349% and 1.350% obtained from arithmetic, geometric and exponential respectively. The doubling time of population was slightly higher (66.67 years) by estimated arithmetic model whereas geometric and exponential models provided respectively 49.51 and 49.65 years, which is consistent estimate of doubling population of Nepal

(CBS, 2011). As fitting the models, the estimated growth rates so obtained here are quite same for geometric and exponential models as of about 50 years population doubling time as compared to the arithmetic growth rate of 1.444 per cent per annum of higher population doubling time of about 67 years. It is quite difficult to ascertain the growth pattern of Nepal. In fact the geometric growth model considered to the progression in which the population increases or decreases at a same rate over each unit of time but the arithmetic growth rate assumed to be constant over each unit of time whereas the exponential growth rates considered the compounds increment or decrement of population continuously at every instant of time, which would follow the recent population growth trend of Nepal.

CONCLUSIONS

The present paper estimates the population growth rates through arithmetic, geometric and exponential growth models of Nepal. The time required for doubling the population was estimated. The trends of population growth rates were found to be 2.1 in 1971, 2.6 in 1981 and again it was 2.1 in 1991, 2.25 in 2001 and it came down to 1.35 per cent annually in 2011. About 4% populations were residing in urban areas in 1971, 6.4% in 1981, 9.2% in 1991, 14.2% in 2001 and 17% in 2011. The population density rose from 79 in 1971 to 181 in 2011. The differentials of population structures are largely varied where the growth rate was higher in urban and better off regions as compared to that of the backward and rural areas. Urban growth rate was 7% whereas it was 2% for rural areas. The population change was found to be 40% in urban and 11% in rural areas during 2001-2011 while the growth rates were accounted to be 2.25% in 2001 and 1.35% in 2011. The overall change was found to be 14% during 2001-2011, which imply that the population changes were larger in urban areas followed by Central, Tarai, Mid-western, Far-western, Hills, Eastern and Western Nepal. The larger number of populations was observed among Kathmandu, Morang, Rupandehi, Jhapa and Kailali districts whereas the smaller number of population among Manang, Mustang, Dolpa, Rasuwa and Humla districts of Nepal. The estimated growth rates were found to be 1.444%, 1.349% and 1.350% by arithmetic, geometric and exponential respectively. The estimated time period for doubling populations was found to be 66.67, 49.51 and 49.65 years obtained by arithmetic, geometric and exponential respectively. The exponential growth rates considered the compounds increment or decrement of population continuously at every instant of time, which would follow the population trend of Nepal. The findings of this paper may help policy-makers and planners for designing population policy of Nepal.

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