Population Forecasting for Design of Dhrafad Regional Water Supply System, Gujarat

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Abstract

Population forecast is a scientific procedure to work out future population scenario. In order to sustain the region water supply scheme over the period of time and to propose the improvement in existing region water supply scheme consumption and design parameters are depending on population of today and coming 4-5 decades. The design population is estimated considering all the factors governing the future growth and development of the project area in the industrial, commercial, educational, and social and administration spheres. Special factors causing sudden immigration or influx of population should also be considered. In present study Population of four decades from 1971 to 2001 is taken as base and forecasted from the year 2013 to 2043. Increase in population over decades is calculated and mean of increase is worked out the paper we presented the population forecasting is done for 31 villages of Dhrafad regional water supply system, using average of results obtained by Incremental increase method, Arithmetic progressive method and Geometric progression method. The statistics of projected population is the basic criteria for the addition of diameter of pipe and its length. Also the magnitude of total head assigned to reservoir and horse power capacity of pump may be prescribed as design parameter of region water supply scheme.

Keywords: forecasting, geometric progression, arithmetic mean, water supply scheme

I. INTRODUCTION

Population forecasting is very important to know the growth of particular area. Agricultural resources and urban facilities are managed based on Population projection. Variations in population are agents of change, inducing many of the environmental, economic and social changes, concerns about human survival, health and wellbeing are the reasons for our interest in global change. Forecasts of the population and its various structures are the most important inputs to global change scenarios. Planning for the future requirements of the population has become the major concern of the planners and requires accurate estimates of the future population growth. Assumptions used forms a critical input in mathematical analysis. Caution must be taken while making or using the population projections in the context of various conditions imposed.

In the present study we develop population projection for Dhrupad regional water supply scheme of Visavadar taluka of Junagadh district using average of Arithmetic progressive method, Incremental increase method and Geometric progression method. Detailed implementation procedure and the outcomes are presented in the subsequent sections.

II. DHRAFAD REGIONAL WATER SUPPLY SCHEME

There are 31 villages of Visavadar taluka of having population of 56660 in this regional water supply scheme. Dhrafad dam is the source of Dhrafad regional water supply scheme and situated near village Sarsai on Dhrafad River.

From Dhrafad dam i.e. surface source the raw water is pumped to the water treatment plant of capacity 7.50 MLD. The treated water is then distributed to the village G.L. Cisterns through service reservoirs G.L. sump or elevated water tanks. For proper use of water, the distribution gravity main system is divided into four zones 1, 2, 3, 4A & 4B. The ultimate distribution is through internal pipeline and stand post. The distribution system includes 2 elevated service reservoir, sump and pump house with machinery gravity main and rising main pipeline (Vyas et al, 2013).

III. POPULATION PROJECTIONS: METHOD AND ASSUMPTIONS

The district of Junagadh is located in Saurashtra region of Gujarat. Administratively the district is divided into eleven towns and fourteen taluka, one of them is Visavadar taluka. It consists of 102 no. of villages and 1 town. Visavadar town is located on South-East of the district. The town is a small Commercial Centre for the people of 102 villages. The total land area is 26.12 Sq. km. Geologically, it is a plain terrain but partially hilly.

Population projections have been made with 2001 as the base line using Incremental increase, Arithmetic mean and Geometric progression method.

A. Arithmetic mean method

This method is generally applicable to large and old cities. In this method the average increase of population per decade is calculated from the past records and added to the present population to find out population in the next decade. This method gives a low value and is suitable for well settled and established communities.

$$P_n = P + nI$$

where,
n= number of decades
I= avg. of increment per decade
P=Population in base year

Population of four decades from 1971 to 2001 is taken. Increase in population over decades is calculated and mean of increase is worked out. Using the above formula population for the period of 30 years (2013 to 2043) is obtained as shown in Table. 1.

Table – 1
Population forecast using arithmetic mean method

Village	*Arithmetic method*			*Village*	*Arithmetic method*		
	2013	*2028*	*2043*		*2013*	*2028*	*2043*
Ambala	*961*	*1075*	*1188*	*Moniya*	*2996*	*3322*	*3647*
Baradiya	*3090*	*3349*	*3609*	*Monpuri nani*	*2954*	*3022*	*3090*
Juni-chavand	*1502*	*1663*	*1824*	*Rabarika*	*761*	*825*	*888*
Navi-chavand	*257*	*249*	*242*	*Rupavati*	*414*	*439*	*463*
Chhalda	*1051*	*1251*	*1451*	*Sarsai*	*5128*	*5255*	*5383*
Dadar	*1820*	*1936*	*2052*	*Shobhavadala gir*	*753*	*768*	*783*
Desai vadala	*689*	*773*	*857*	*Vajdi*	*702*	*794*	*886*
Ghantiyan	*172*	*186*	*200*	*Sukhpur*	*741*	*715*	*688*
Ishwariya mandavad	*1204*	*1381*	*1558*	*Bhutdi*	*1744*	*1976*	*2208*
Khambhadiya	*2239*	*2633*	*3028*	*Virpur*	*1724*	*1713*	*1703*
Khijadiya	*1010*	*1135*	*1261*	*Kalsari*	*6395*	*7351*	*8307*
Kotda nana	*1759*	*1986*	*2213*	*Chaparda*	*1463*	*1386*	*1309*
Kuba ravani	*959*	*801*	*643*	*Sirvaniya*	*327*	*328*	*329*
Leriya	*2166*	*2476*	*2786*	*Ravani kuba*	*1731*	*2053*	*2375*
Mandavad	*1114*	*1268*	*1423*	*Shetranj Vadala*	*1906*	*2037*	*2167*
Mangnath pipdi	*1209*	*1272*	*1335*				

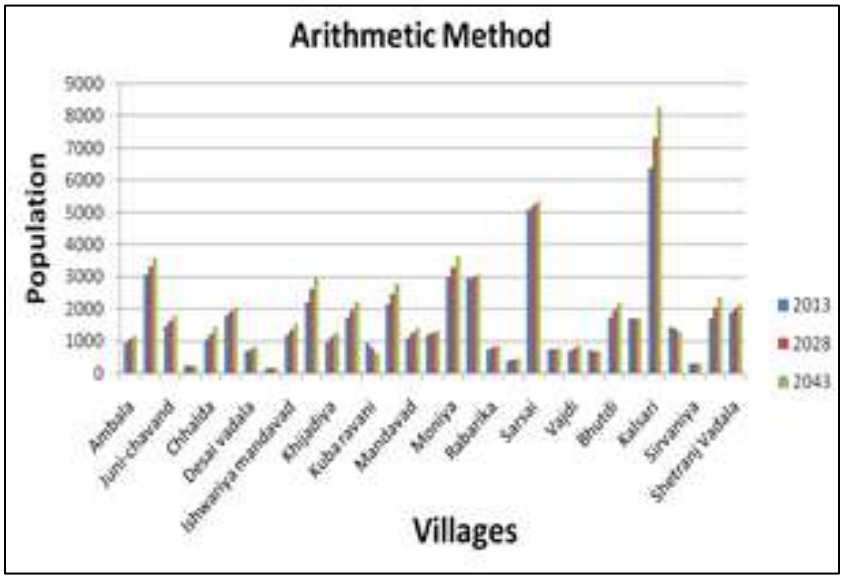

Fig. 1: Arithmetic Method

B. Geometric progression method

In this method percentage increase is assumed to be the rate of growth and the average of the percentage increase is used to find out future increment in population. This method gives much higher value and is mostly applicable for growing towns and cities having vast scope for expansion.

$$Pn = P\,(1+Ig/100)^{n}$$

where,
n= number of decades
Ig=avg. % increment per decade
P=Population in 2001

Population of four decades from 1971 to 2001 is taken. Percentage increase in population over decades is calculated and geometric mean of increase is worked out. Using the above formula population for the period of 30 years (2013 to 2043) is obtained as shown in Table 2.

Table – 2
Population forecast using Geometric progression method

Village	*Geometric method*			*Village*	*Geometric method*		
	2013	*2028*	*2043*		*2013*	*2028*	*2043*
Ambala	*1117*	*2405*	*3693*	*Moniya*	*3535*	*7614*	*11693*
Baradiya	*3720*	*8012*	*12304*	*Monpuri nani*	*3763*	*8106*	*12448*
Juni-chavand	*1770*	*3812*	*5853*	*Rabarika*	*925*	*1993*	*3060*
Navi-chavand	*342*	*736*	*1131*	*Rupavati*	*501*	*1078*	*1656*
Chhalda	*1162*	*2502*	*3843*	*Sarsai*	*6520*	*14043*	*21566*
Dadar	*2235*	*4813*	*7392*	*Shobhavadala gir*	*966*	*2081*	*3195*
Desai vadala	*769*	*1656*	*2543*	*Vajdi*	*810*	*1745*	*2680*
Ghantiyan	*200*	*431*	*662*	*Sukhpur*	*993*	*2139*	*3285*
Ishwariya mandavad	*1366*	*2943*	*4519*	*Bhutdi*	*1997*	*4302*	*6606*
Khambhadiya	*2491*	*5366*	*8240*	*Virpur*	*2253*	*4853*	*7452*
Khijadiya	*1174*	*2529*	*3885*	*Kalsari*	*7258*	*15633*	*24008*
Kotda nana	*2024*	*4360*	*6696*	*Chaparda*	*1989*	*4284*	*6579*
Kuba ravani	*1424*	*3068*	*4711*	*Sirvaniya*	*424*	*914*	*1404*
Leriya	*2470*	*5321*	*8171*	*Ravani kuba*	*1877*	*4043*	*6209*
Mandavad	*1268*	*2731*	*4194*	*Shetranj Vadala*	*2331*	*5021*	*7710*
Mangnath pipdi	*1500*	*3232*	*4963*				

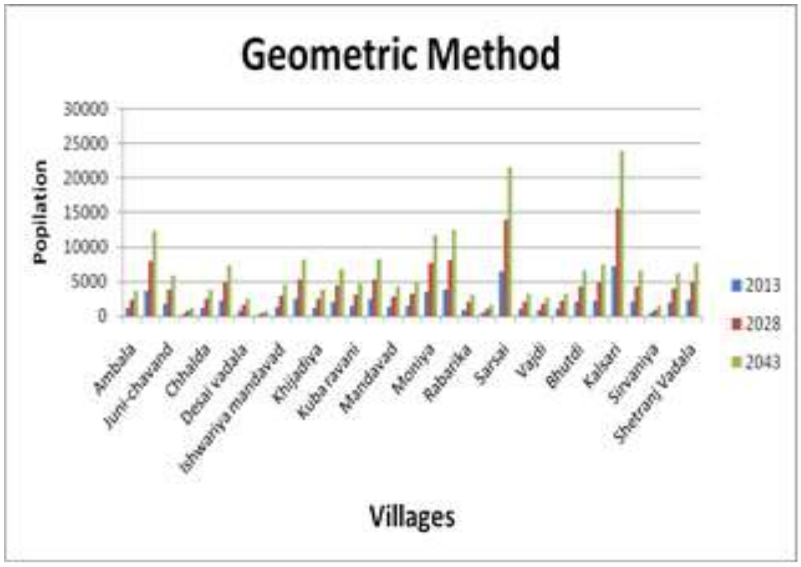

Fig. 2: Grometric Method

C. *Incremental increase method*

In this method the increment in arithmetical increase is determined from the past decades and the average of that increment is added to the average increase. This method increases the figures obtained by the arithmetical increase method.

$$Pn = P+nI+n\{(n+1)/2\}*r$$

where,
n=number of decades
I= avg. of increment per decade
r=Incremental Increase

Population of four decades from 1971 to 2001 is taken. Increase in population over decades and incremental increase is worked out. Using the above formula population for the period of 30 years (2013 to 2043) is obtained as shown in Table 3.

Table – 3
Population forecast using Incremental increase method

Village	*Incremental increase method*			*Village*	*Incremental increase method*		
	2013	*2028*	*2043*		*2013*	*2028*	*2043*
Ambala	*1158*	*1499*	*1839*	*Moniya*	*3560*	*4537*	*5514*
Baradiya	*3540*	*4318*	*5097*	*Monpuri nani*	*3072*	*3276*	*3480*
Juni-chavand	*1781*	*2264*	*2747*	*Rabarika*	*871*	*1062*	*1252*
Navi-chavand	*242*	*216*	*187*	*Rupavati*	*457*	*530*	*604*
Chhalda	*1398*	*2000*	*2602*	*Sarsai*	*5348*	*5731*	*6113*
Dadar	*2021*	*2369*	*2717*	*Shobhavadala gir*	*779*	*824*	*869*
Desai vadala	*834*	*1086*	*1338*	*Vajdi*	*861*	*1137*	*1413*
Ghantiyan	*196*	*238*	*280*	*Sukhpur*	*695*	*616*	*536*
Ishwariya mandavad	*1511*	*2042*	*2573*	*Bhutdi*	*2146*	*2842*	*3538*
Khambhadiya	*2923*	*4106*	*5290*	*Virpur*	*1706*	*1674*	*1643*
Khijadiya	*1227*	*1603*	*1979*	*Kalsari*	*8052*	*10920*	*13788*
Kotda nana	*2152*	*2833*	*3514*	*Chaparda*	*1330*	*1099*	*868*
Kuba ravani	*685*	*211*	*263*	*Sirvaniya*	*329*	*332*	*334*
Leriya	*2703*	*3633*	*4563*	*Ravani kuba*	*2289*	*3255*	*4221*
Mandavad	*1382*	*1845*	*2309*	*Shetranj Vadala*	*2132*	*2524*	*2915*
Mangnath pipdi	*1318*	*1506*	*1695*				

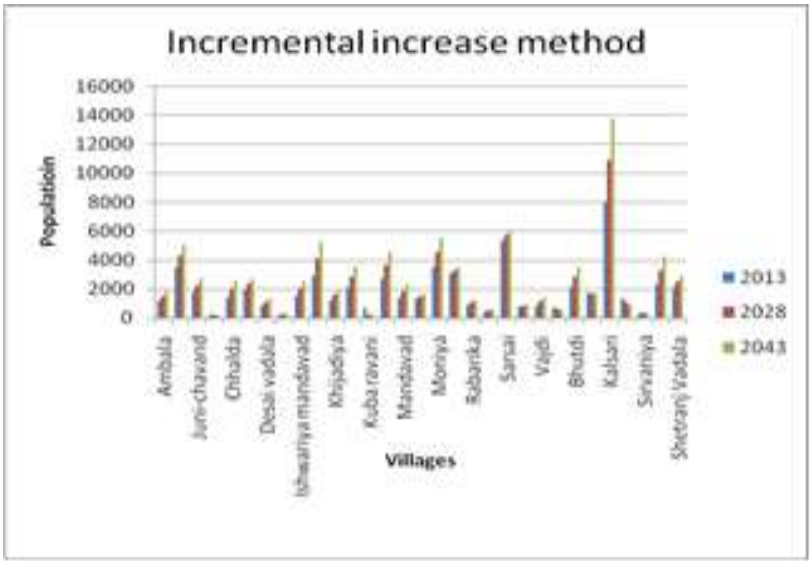

Fig. 3: Incremental Increase Method

Average value of all three methods is adopted for the population projection as shown in table-4.

Table - 4
Average of all three methods

Village	*Population served*			*Village*	*Population served*		
	2013	*2028*	*2043*		*2013*	*2028*	*2043*
Ambala	*1079*	*1660*	*2240*	*Moniya*	*3364*	*5158*	*6952*
Baradiya	*3450*	*5227*	*7004*	*Monpuri nani*	*3263*	*4802*	*6340*
Juni-chavand	*1685*	*2580*	*3475*	*Rabarika*	*853*	*1294*	*1734*
Navi-chavand	*281*	*401*	*520*	*Rupavati*	*458*	*683*	*908*
Chhalda	*1204*	*1918*	*2632*	*Sarsai*	*5666*	*8343*	*11021*
Dadar	*2026*	*3040*	*4054*	*Shobhavadala gir*	*833*	*1225*	*1616*
Desai vadala	*764*	*1172*	*1580*	*Vajdi*	*791*	*1226*	*1660*
Ghantiyan	*190*	*285*	*381*	*Sukhpur*	*810*	*1157*	*1503*
Ishwariya mandavad	*1361*	*2122*	*2884*	*Bhutdi*	*1963*	*3040*	*4118*
Khambhadiya	*2551*	*4035*	*5520*	*Virpur*	*1895*	*2747*	*3600*
Khijadiya	*1137*	*1756*	*2375*	*Kalsari*	*7235*	*11302*	*15368*
Kotda nana	*1979*	*3060*	*4141*	*Chaparda*	*1594*	*2257*	*2919*
Kuba ravani	*1023*	*1360*	*1697*	*Sirvaniya*	*360*	*525*	*689*
Leriya	*2447*	*3810*	*5174*	*Ravani kuba*	*1966*	*3117*	*4269*
Mandavad	*1255*	*1948*	*2642*	*Shetranj Vadala*	*2123*	*3194*	*4264*
Mangnath pipdi	*1343*	*2004*	*2665*				

IV. CONCLUSION

The population forecast carried out using Arithmetic progressive, Incremental increase and Geometric progression method provides qualitative support to the planning, design and allocation of water resources project. In this we have shown 1.3, 2.8, and 4.5 decades population increases for years 2013, 2028, 2043 respectively, compared to the base year 2001. The population forecasting for design period of 30 years is obtained so that water supply network can be designed for Dhrafad regional water supply scheme. The statistics of estimated population is basic consideration for the addition of diameter of pipe and its length. Also the magnitude of total head assigned to reservoir and capacity and type of pump may be prescribed.

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