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A Strategic Water Supply Design to Kadapa Town from Gurramgumppu Reservoir

Kiran Kumar. T[1] and Srihari Vedartham[2*]

[1]Department of C.E, K.S.R.M. College of Engineering (Autonomous), Kadapa, Andhra Pradesh, India
[2]NICMAR, Shamirpet, Hyderabad, India

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ABSTRACT

Kadapa is a town in the Rayalaseema area of southern side of state Andhra Pradesh, India, commonly known as the key-part of Rayalaseema. It serves as the important business centre in YSR district. The city had a population of 344,078 according to the 2011 Indian census. It's approximately 8.0 kilometres (5.0 miles) south of the Penna River. Due to unpredictable and uncertain rains, the Kadapa is a drought prone area; in fact, more than 75% of the mandal is a drought area. As a result, the government declared drought-prone areas not just in mandals, but also in urban areas with more than ten panchayats facing drinking water shortages. As a result of the aforementioned circumstances, the government of Andhra Pradesh created the Galeru Nagari Sujala Sravanthi Project [GNSS] project for water supply in drought prone area.

Key words: *Drought prone area, Water supply, Intake structure, Infiltration well, Storage tank*

Introduction

Kadapa is located in the Rayalaseema area of Andhra Pradesh, at 14.47°N 78.82°E, approximately 412 kilometres from Hyderabad and approximately 280 km from city Bangalore. The city is located in the Bugga (also called Rallavanka), which is bounded to the southern side by the palakondas, eastern side by a series of hills and northen side covered by the lankamalas on penna's other side. It has an elevation of 452 feet (138 metres). The district headquarters of the Y.S.R district is Kadapa Municipal Corporation (Arunkumar and Mariappan, 2011; Prasad *et al*., 2014). It was elevated from the selection category of municipality to Municipal Corporation in 2005. It covers an area of 164.08 square kilometres. It's constituted of the 50 election wards. The periodic average downfall in the Kadapa city is about 753 mm. the average elevation position of the ground in Kadapa city is +138.000 and in the Kadapa city 40,462 individual water house service connections are present. The water consumption 116 lpcd during normal season and 71 lpcd during summer season. Penna swash is the main source of water supply to Kadapa city (Brackenbury, 2000; Kumar and Niveditha, 2021). Water flows in the swash from July/august to February. The below first two sources are positioned on the bank of Penna swash are at a distance of 8 km and 16 km independently from the city. Besides, there are tube wells and open wells fitted with pump sets and connected to the being distribution system to condense water. At present the corporation is supplying 11.50 MLD from Gandi source and 30 MLD from Lingampalli source and 2.60 MLD from Bugga and other drag wells fitted with pump sets in colorful points in city

([1]Professor, [2]Professor)

(Reddy *et al.*, 2000). The total drawl works out to 44.10 MLD. The supply is 116.00 lpcd for the present population of 3, 79,209 which is lower as per CPHEEO guidelines. Still there are about 41,000 no's of homes aren't having house service connections. Those homes are getting the drinkable water through public gates, neighbor houses and water tankers. It's proposed to give house service connections in a phased manner and presently about 9,000 number of house service connections [HSCs] are proposed. By adding the population day by day the daily water supply (116.0 lpcd) to Kadapa city isn't sufficient. Hence, a study of water supply from Gurramgumppu reservoir is found to be useful for the future demand of Kadapa town.

According to global census andas per world health association (WHA) report, 110 crore people around the world demanded access to advanced water supply and further 40 percent of the world's population demanding access to better sanitation in 2000. In response to this, every country working on better water supply and sanitation development byadding number of states, transboundary water conferences, and aid associations have blazoned series to ameliorate global access to fresh water and water-related services (Kumar *et al*., 2005; WHO, 2000). The drinking water access in India has increased over the past decade, but unsafe water continues to have a tremendous adverse effect on health (WHO, 2004). It is expected that approximately 21 per cent of transmissible situations in India is water-related problems. The present study is carried out to estimate future demand and possible ways of supply water to Kadapa town for a period of 30 years.

Study Area

Kadapa geographically is located at14.47° N, 78.82° E approximately 412 km from Hyderabad and covered with hills of western and eastern Ghats stand on either aspects, defensive it from the acute winds of summer season and downtime. Kadapa has a tropical moist and dry weather characterized with the aid of time round excessive temperatures. It has a report of attaining similarly than 50 °C summers are in particular uncomfortable with warm and sticky climate. The atmospheric moisture is round seventy five percent throughout the summer time months. Thunderstorm season brings good sized rain to the region. Kadapa gets downfall from each the South west thunderstorm in addition to the North East Monsoon. June to October is commonly the thunderstorm. Winters are relatively milder and the temperatures are decrease after the onset of the showers and winter season is the stylish time to go to the location.

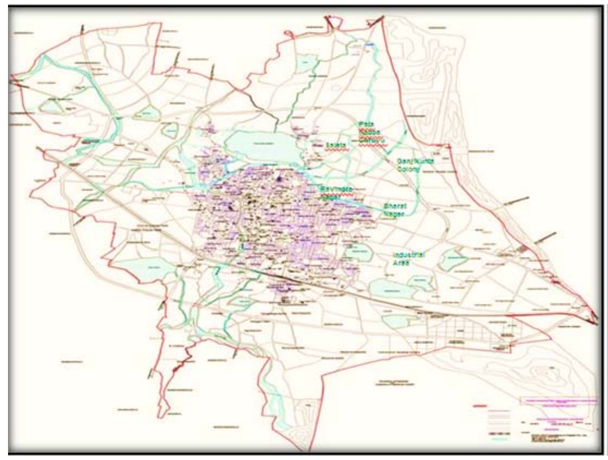

Fig. 1. Kadapa town base map

Kadapa Municipal Corporation is the headquarters of the Y.S.R district. In 2005, it's upgraded from the selection grade of megacity to Municipal Corporation. It's spread over the area of the164.08sq.km. It's constituted of the 50 election wards. The periodic average downfall in the Kadapa city is about 753 mm. The average elevation position of the ground in Kadapa city is 138.000 and in the Kadapa city 40,462 individual water house service connections are present. The water consumption 116 lpcd during normal season and 711 pcd during summer season. In Kadapa 220 kms of pucca and katcha storm water rain spouts are constructed. The solid waste is collecting and treating at scrap yard. There are 14 ELSR's (Elevated Service Reservoir) located at different locales with total capacity of 12,128 Kilo Liters[KL].

Details of Water Supply

Penna River is the prime source of water supply to Kadapa Town. Water flows in the swash from July/ August to February. Following are the three main Head water works Gandi water workshop. Lingampalli head water works taken over by Kadapa megacity from APIIC in June 1994. Bugga water workshop and Extra drag wells fitted with pump sets in city (Punmia *et al*., 2009). The below first two sources are positioned on the bank of Penna swash are at a distance of 8 KM and 16 KM independently from the city. Besides the over there are tube wells and open wells fitted with pump sets and connected to the being distribution system to condense water. At present the reservoir is supplying 11.50 MLD from Gandi source and 30 MLD from Lingampalli source and 2.60 MLD from Bugga and other drag wells fitted with pump sets in colorful points in city. The total drawl works out to 44.10 MLD. The pro rata supply is 116.00 lpcd for the present population of 3, 79,209 which is lesser as per CPHEEO guidelines. The infiltration well installing capacities distributions are given in Table 1 and present Kadapa Municipal Corporation is serving the purpose through the following resources

- Through infiltration wells, infiltration gallery points in swash penna at lingampalli
- From infiltration well in swash penna at rammannapally.
- From drag wells in buggavanka and from original drag wells.

Table 1. The infiltration well installing capacity distributions

S. No.	Source	Installed (MLD)	Normal Supply Present (MLD)
1.	Gandi	15.00	12.00
2.	Lingampalli	50.00	30.00
3.	Bugga and local Bores	2.10	2.10
4.	Ramannapally	2.00	0.60
	Total	69.10	44.70

Methodology

Estimation of Population

Kadapa population of 344,078 as per 2011 census, the unborn population can be estimated by using population soothsaying styles in various methods recommended by CPHEEO, CPWD, WHO and other water works department standards. The various styles which are generally adopted for estimating unborn populations by masterminds are described below. Some of these styles are used when the design period is small, and some are used when the design period is large. The particular system should be espoused for particular case or a particular megacity depends largely upon the factors bandied in these styles, the selection is left to the discretion and intelligence of the developer. still as refocused out before, none of these styles is exact, and they're all grounded on the laws of probability, and therefore, only approximate estimates for the possible unborn populations can be made. The unborn population stylesare (i) computation Increase system, (ii) Geometric Increase system, (iii) Incremental Increase system, (iv) Decreasing Rate of Growth system.

Estimation of Water Demand

The term 'domestic water' refers to the water used for various activities in households such as drinking, cooking, bathing, gardening, and cleaning. The amount of water consumed per person depends on their living conditions. According to the IS1172-1993 guidelines, a city or megacity with a full flushing system should consume a minimum of 200 liters of domestic water per person per day, which could be reduced to 135 liters for economically weaker sections and LIG colonies based on the prevalent conditions. This bifurcation of 200 liters and 135 liters per person accounts for various factors and is crucial in ensuring an optimal supply of domestic water.

Design of Storage Water tank

A tank is a container that holds water. Water tanks are used as water supplies for a variety of purposes, including drinking water, irrigated agriculture, fire fighting, agricultural diversion for businesses and animals, chemical manufacturing, food and pharmaceutical, and many other purposes (Punmia *et al.*, 2009). Water tank parameters include the general design of the tank, selection of construction equipment and filling. Create an aquarium using colorful accessories made of plastic (polyethylene, polypropylene), fiberglass, concrete, tombstones, swords, etc. Dirt corridors also act as water reservoirs. Water tanks are an effective way to enable developing countries to store clean water (Fair *et al.,* 1966).

Design and Working Operation of factors

A reservoir is an artificial lake or a large brackish body of water. Many people assume a reservoir to be a lake, and may in fact use the words interchangeably. Reservoirs are man-made, whereas lakes are bodies of water by nature. It saves a lot of money as it provides a reservoir in case natural bodies of water such as lakes and gutters are depleted.

Intake structure

Intake structures are used to collect water from surface sources such as lakes and reservoirs and send it to water treatment plants (Burile and Nagarnaik, 2010). These structures are masonry or concrete structures, free of pollution, sandy beaches, and harmful flotsam, and provide relatively clean water.

Results and Discussion

Estimation of Population

The present study analysis started with Population soothsaying for forthcoming 30 times by the computation mean system. The particular system is used for particular megacity depend upon the influencing factors. In these systems the population increases at constant rate. The forecasted population is given in Table 2.

Table 2. Population forecasting

Year	Population	Increase in Population
1981	137937	
1991	210715	72778
2001	256436	45721
2011	344078	87642
Total		206141

Average Increase per Decade, $(\overline{x}) = \frac{206141}{4} = 68713$

(1) Population after 1 decade beyond 2011
In year 2021 = 344078+1×68713 = 412791

(2) Population after 2 decades beyond 2011
In year 2031 = 344078+2×68713 = 481504

(3) Population after 3 decades beyond 2011
In year 2041 = 344078+3×68713 = 550217

Discussion

In literature, the various methods are generally adopted for estimating future populations by the engineers. In some of the method are based on the assumption that the population growth increases at the constant rate (Subramanya, 2017). The estimated population is given in Table 3 and graphical representation as shown in Figure 2.

Estimation of water demand to the Kadapa people

In this step we are going to calculate the water assessment to the Kadapa people and the given data calculation is below:

Present Kadapa population = 3, 83,388.

Minimum water domestic consumption =200 l/d

=7, 66, 77,600 l/h/d

Table 3. Population in Lakhs.

Year	Population in Lakhs
2001	256346
2011	344078
2021	402791
2031	418504
2041	550217

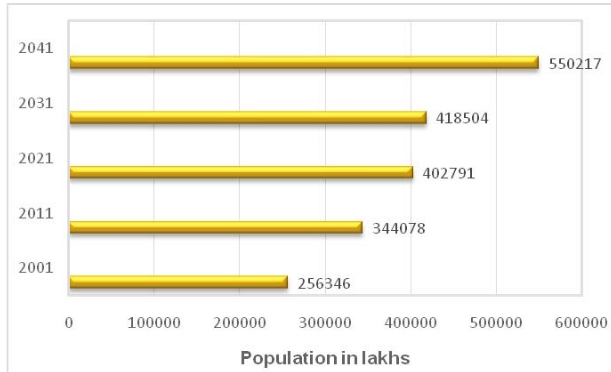

Fig. 2. Population forecasting graph for 30 years

=76.67 MLD

Assuming higher daily demand as 1.8 times average demand

The highest water quantity necessary for Kadapa town = 76.67 × 1.8

= 138 MLD

$$= \frac{138 \times 10^6}{10^3 \times 24 \times 60 \times 60}$$

= 1.59 cumecs

The present Kadapa population is 3, 83,388. As per code provisions the minimum water consumption is 200 l/d. So for the present population of Kadapa town people required the 1.59 cumecs of water and the capacity of Gurramgumppu reservoir is 0.68 TMC. So the water is sufficient to the Kadapa town.

Design of Storage Water Tank

Design of circular water Tank for storing the water that which it is collected from the reservoir (Modi and Seth, 2019). The dimensions and the data of the circular tank are given below:

Capacity of circular tank = 4, 00,000 litres

Height of a tank = 3.5 m =0.0035 mm

Free board = 200 mm

Concrete Characteristic strength (f_{ck}) = 20N/mm^2

Steel Yield strength (f_y) = 415N/mm^2

Dimension of Tank

Depth of water in the circular tank, H = height of tank – free Board

H= 3.5-0.2 = 3.3 m

Volume of circular tank $=\frac{400000}{1000} = 400\ m^3$

Area of circular tank, $A = (\frac{volume}{depth}) = \frac{400}{3.3} = 121.2\ m^2$

Diameter of circular tank, $D = \pi/4 \times D^2 = 121.2$

$= \sqrt{\frac{4\times121.2}{\pi}} = 13$ mts

Thickness is assumed as, t = (30 H+50)

$= (30 \times 3.3 + 50)$

= 160 mm

Design of Reservoir

The proposed reservoir underG.N.S.S Phase-II is named as Single Bund Reservoir at Gurramgumpu Thanda, its geographical Latitude is 14° 23′ 23" for the catchment area of 15.54 Sq.km. the water spread area at FRL is measured as 208.88 Ha and the gross storage capacity noted as 0.638TMC and Maximum flood discharge noted as 130cumecs. The other details are as follows

FRL:+196.000 M, MWL:+196.690 M, TBL :+199.000 M

Length of earthen bund: 2.45 km, Maxi. Height of earthen bund: 25.30 m, Length of spill way: 125 m, and provided with HC weir with a discharge of 157 cumecs

Design of Intake Structure

Velocity of water in reservoir, V = 1.3 m/s

Discharge required (or) tube received by Intake structure, Q = 1.59 cusecs

= 1.590.02831

= 0.045 cusecs

Area of opening required to take water from river by Intake structure

$= Q/V = \frac{0.03}{0.6} = 0.03\ m^2$

Minimum flow depth of water = 0.6 m

Proposed opening is rectangular, Hence breadth

$= \frac{0.03}{0.6}\ \ 0.05$ m

Hence, opening proposed to draw water 1.00.05 m from overcoming adverse condition.

LWL of reservoir = +182.5

Bed level of reservoir = +181.3

Assuming diameter of line as per design standard = 1.2 m

Assuming the diameter of Intake structure as per design = 1.202 = 2.40 m

However, adopt 2 m as diameter of Intake structure [7,8].

Design of Intake Pipe Line

Design discharge = 1.59 cumecs =0.045 cusecs
Bed fall adopted = 1 in 500
Assuming two numbers of 1000 mm ϕ RCC pipes is provided for most economical section.

Area of pipe $= 2\pi \times 1.0^2/_4 \times 2 = 0.78\ m^2$

Wetted perimeter $= \frac{n.D.}{2} = \pi/_2 \times 1.0$

= 1.57 m

Hydraulic mean path = A/P = $\frac{0.78}{1.57}$ = 0.49 m

Using manning's formula, $V = {}^1/_n \times R^2/_3 \times s^1/_2$

$= {}^1/_{0.025} \times (0.49)^2/_3 \times (0.002)^1/_2$

= 1.11 m/sec

Discharge through pipes = 0.781.11

= 0.865 cusecs

Hence the section assumed is safe and can discharge 0.85 cusecs than 0.045 cusecs.

Conclusion

1. In Kadapa there are 78,100 noof homes in that being house service connections are 40,462 nos. so the needed House Service Connections are 37638 nos. so number of connections should be provided to all homes.
2. The existing water source (116.0 LPCD) to Kadapa city isn't sufficient for the population increase day- by- day. So, we planned to supply the sufficient water to Kadapa city from nearest source of supply Gurramgumppu reservoir.
3. The present study carried to design the input structure and the pump house to supply the water from the gurramgumppu reservoir to the Kadapa city.
4. The present design of tank and channels are needed to supply water from reservoir to Kadapa cityto justify for the future demand.

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