FEASIBILTY STUDY OF WATER SUPPLY SCHEME TO KOCHI FROM NERIAMANGALAM

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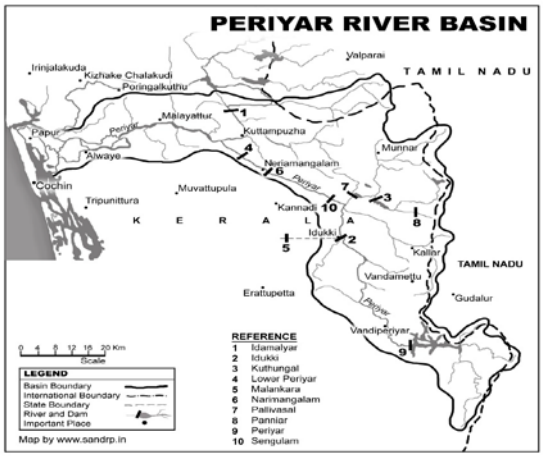
Abstract—*Kochi, one of the major cities in Kerala, has emerged as the commercial and industrial capital of Kerala and is perhaps the second most important city on the west coast of India (after Mumbai). Kochi is located on the southwest coast of India, spanning an area of 94.88 square kilometres. The city straddles the backwaters, encompassing the northern end of a peninsula, several islands and a portion of the mainland. The city has a population of around 22 lakhs. Water demand in this urban area continues to grow because of significant population increase. In addition to the demands of rising population, water consumption in the city has shot up by a huge margin with the rise in development projects and construction activities in the city and its suburbs in the last few decades. As there is no proportionate increase in the supply, this leads to acute drinking water shortage. Though the rainfall is high, proximity to the sea and pollution from industrial and domestic sources makes the surface and groundwater not usable, especially in the western parts of Kochi. Water need and water availability are not proportional to rise in population. hat flows in the states of Tamil Nadu and Kerala, India. It is one of the few perennial rivers in the region and provides drinking water for several major towns. The river is mostly located in Kerala and generates a significant proportion of that state's electrical power via the Idukki Dam. Due to these reasons, the river has been named the 'Lifeline of Kerala'. It is the longest river and the river with the largest discharge potential in Kerala. Thus there is a need to need to ensure alternative water supply scheme for Kochi*

Keywords—Water supply schemen; Water Quality Analysis

1. INTRODUCTION

Having safe drinking water and basic sanitation is a human need and right for every man, woman and child. People need clean water and sanitation to maintain their health and dignity. Having better water and sanitation is essential in breaking the cycle of poverty since it improves people's health, strength to work, and ability go to school. Yet 884 million people around the world live without improved drinking water and 2.5 billion people still lack access to improved sanitation, including 1.2 billion who do not have a simple latrine at all (WHO/UNICEF, 2008). Many of these people are among those hardest to reach: families living in remote rural areas and urban slums, families displaced by war and famine, and families living in the poverty-disease trap, for whom improved sanitation and drinking water could offer a way out.



A. NEED FOR THE STUDY

Currently, water is supplied to Kochi from Aluva. Though the installed capacity of the Aluva plant is 225 MLD, the authority had supplied 260MLD from the plant for the last several years. After renovation works, the quantity has gone up to 280MLD. Of the 280MLD generated, 261MLD is supplied to Kochi and its suburbs, while the remaining 19MLD is distributed to Aluva, Keezhmadu and Choornikkara. Present, the total water demand of the city is 400 MLD (326 MLD for domestic and agricultural sectors and 74 MLD for industrial use). Even with special augmentation schemes and different projects city still faces a shortage of 120 MLD. Private water tankers which draw water from various wells and other water bodies in different parts of the district supply approximately 43 MLD of water. There are thousands of people travelling daily to the city in daytime for jobs from nearby area and their water use and need are not accounted. Hence it is essential to find additional source for water supply

B.OBJECTIVES AND SCOPE OF THE WORK

The lower reaches of the Periyar are heavily polluted. Industries in the Eloor industrial zone discharge waste into the river. Greenpeace India describes the lower Periyar as "a cesspool of toxins, which have alarming levels of deadly poisons like DDT, endosulfan, hexa and trivalent chromium, lead, cyanide, BHC. Several studies have pointed out that the riverbed has deposits of heavy metals like lead, cadmium, mercury, chromium, nickel, cobalt and zinc and the ecosystem of the river has many dead zones. Some of the major recommendations are ensuring zero effluent discharge from the industrial units in the Eloor-Edayar stretch and zero emission from companies. Pollution of the river and surrounding wetlands has almost wiped out traditional

occupations, including fishing and farming. Neriamangalam being on the upper reach of the river, is away from industrial areas and hence water quality will be considerably good. Also, the setting up of a new plant or expansion of the existing plant in Aluva will be difficult due to increased developmental activities and pollution.

The main objectives of the project are to: (I) conduct microbiological and chlorine residual tests on untreated and treated water supplies, respectively, and (II) apply the results of the microbiological tests and sanitary surveys to identify at-risk water supplies in order to make recommendations for potential infrastructure upgrades and improvements to these drinking water system.

- To analyze the quality of drinking water in Kochi area.
- To forecast the water demand for Kochi
- To propose an alternative water supply scheme from Neriamangalam to Kochi
- To design a water treatment plant for the river

2. REVIEW OF LITERATURE

Investigations carried by various researchers in the selected topic of study are briefly narrated below.

A. A review of the qualitative analysis & treatment for drinking water in educational institutes

Samples of twenty one educational institutions were tested for physical, chemical and biological parameters and their results were compared with ICMR and WHO drinking water standards. Variation has been found in few parameters during the season wise with acceptable permissible limit. The stable limit was found in temperature, pH, EC and Alkalinity. The excess amount of DO was found since ground water concern. No seasonal variation has been noted. The total solid was found in negligible amount. The samples of twenty one educational institutions were tested for physical, chemical and biological parameters and their results were compared with ICMR and WHO drinking water standards. Variation has been found in few parameters during the season wise with acceptable permissible limit. overview of the impact indicators that the Trust might utilise to evaluate future restoration programmes.

B. Sustainability Approach for Planning and Design of Water Supply Scheme

The most viable alternatives out of the various projects considered was evaluated using decision matrix methods based on a sustainability approach. The various possible alternatives projects based on water sources in Naharlagun area in Arunachal Pradesh were considered in the present study. After the preliminary survey, three alternatives projects based on the water sources available in the study area were identified. They were A1-Pachin river, A2-Dikrong river and A3-Niroch nallah. These alternatives are then evaluated for sustainability considering different factors. Technical soundness was observed as the most important decision factor in the Paired Comparison Technique. The project based on the Pachin river was found to be the most viable alternatives from the Alternatives Choice Coefficient (ACC) analysis.

C. Prediction of water demand and water storage capacity of municipal system by using geospatial techniques

The uneven growth of urban population leads to the failure in the sustainable development of basic amenities such as water, due to increase in demand. There is an urgent need for providing adequate storage capacity to meet the need of water for growing population. In this research work, the remote sensing satellite image of LISS-4 and Cartosat1 along with the GIS and Differential Global Positioning System (DGPS) technique is used for the precise estimation of water storage capacity. The investigations were done based on the population density and existing storage capacity. The water requirement as well as the existing storage is analyzed using analytical methods for Bhopal area. It was found that the density of population in zone 4 is increasing by 528 p/ha and storage requirement is insufficient due to increase in population.

3. METHODOLOGY

A.Study of properties of water

The properties of water is mainly divided in to three:

1 Physical properties
2 Chemical properties
3 Biological properties

1) pH: pH is a measure of the relative acidity or alkalinity and it represents the negative logarithm of the concentration of free hydrogen ions in a solution. Scale of pH ranges from 0 to 14 with 7 as neutral; below and above this value, the solution can be respectively deemed acidic or alkaline. In this phase, the pH value of water was measured by the use of a pH indicator paper.

2) Hardness: Hardness of water is mainly due to the presence of calcium and magnesium ions in it. These ions may be in combination with carbonates and bicarbonates apart from sulphates, chlorides, and nitrates. In this phase, hardness of water was measured by EDTA titration method.

3) Chloride: Chloride was estimated by Mohr's titration method. In this method, chloride containing sample was titrated with silver nitrate in the presence of potassium chromate to form a slight soluble white precipitate of AgCl. A brick-red solution of silver chromate was formed at the end point owing to the reaction of slight excess of silver nitrate with potassium chromate.

4) Total Dissolved Solids: Total dissolved solids in water can be defined as the residues left after evaporation of a filtered sample. It was determined by the evaporation method of filtered sample followed by gravimetric analysis.

5) Iron: Phenonthroline method was used to determine the concentration of iron. Iron occurs in natural waters in oxidised (ferric) as well as reduced (ferrous) states. All of the iron was converted into the ferrous state through boiling with hydrochloric acid in the presence of hydroxylamine. The reduced iron chelated with 1, 10-phenonthroline at a pH range of 3.2 to 3.3 to form a complex having an orange-red

sufferings enlisted by these local dwellers. On the task of giving an opinion on canal restoration, all of the interviewees stood by the same sentiment that the TS canal should be resurrected as soon as possible not just for the society but for the nation as a whole. A majority of these people were of the opinion that the government had made ineffective attempts in this regard until this point in time. On further enquiry they revealed that they had said so because certain government authorities were involved in canal dredging works in the past. Due to lack of proper supervision and leadership they got indulged in sand mining works that led to soil erosion along the canal banks and the subsequent formation of cracks in nearby buildings.

6) Nitrate: The sample under consideration was made to pass through a column containing copper coated cadmium. The nitrate content in the sample was determined by diazotizing it with sulfanilamide dihydrochloride. The resulting water soluble dye yielded a magenta color which was read at 520 nm.

7) Coliforms: Multiple tube fermentation technique was used to determine the concentration of coliforms (total and faecal) in the concerned samples. The technique involved inoculation of the sample in a suitable liquid medium. After the expiry of the incubation period, the tubes were examined for gas production by the coliform organisms. This presumptive test was followed by a confirmatory test for all those samples which yielded positive results.

B.Water Quality Analysis

Samples must be taken from locations that are representative of the water source, treatment plant, storage facilities, distribution network, points at which water is delivered to the consumer, and points of use. In selecting sampling points, each locality should be considered individually. Sampling points should be selected such that the samples taken are representative of the different sources from which water is obtained by the public or enters the system. These points should include those that yield samples representative of the conditions at the most unfavourable sources or places in the supply system, particularly points of possible contamination such as unprotected sources, loops, reservoirs, lowpressure zones, ends of the system, etc. Sampling points should be uniformly distributed throughout a piped distribution system, taking population distribution into account; the number of sampling points should be proportional to the number of links or branches. The points chosen should generally yield samples that are representative of the system as a whole and of its main components. Sampling points should be located in such a way that water can be sampled from reserve tanks and reservoirs, etc. In systems with more than one water source, the locations of the sampling points should take account of the number of inhabitants served by each source. There should be at least one sampling point directly after the clean-water outlet from each treatment plant.

Kochi Area Map

The following samples were collected

1. Tap water from homes
3. Water from community well
4. Water from nearby college
5. Water from Neriamangalam river

The results of samples collected are analysed as following:

Table 1 Quality of water from tap water

Tests	Results	IS standards	
		Desirable limits	Permissible limits
Alkalinity	31.4	200	600
Acidity	0	-	-
Hardness	1.83	300	600
Turbidity	7	5	10
pH	6.43	6.5	8.5
Chlorides	5.65	250	1000
DO	1.1	14.6(0^o C) -7 (35^o C)	

It is observed thatalkalinity, hardness, turbidity, chloride are within the safe limit. The pH of tap water is 6.43 which show that water is slightly acidic. The dissolved oxygen present in the water is 1.1 mg/L which is not within the desirable limit therefore aeration is needed.

Table 2 Quality of water from nearby college

Tests	Results	IS standards	
		Desirable limits	Permissible limits
Alkalinity	30.6	200	600
Acidity	0	-	-
Hardness	2.85	300	600
Turbidity	6.2	5	10
pH	5.41	6.5	8.5

Chlorides	10.43	250	1000
DO	0.95	14.6(0^o C) -7 (35^o C)	

We observe that alkalinity, hardness, turbidity, chloride are within the safe limit. The pH is 5.41 which show that water is slightly acidic. The residual chlorine is not present in the water therefore chlorination is needed. The dissolved oxygen present in the water is 0.95 mg/L which is not within the desirable limit therefore aeration is needed.

Table 3 Quality of water from community well

Tests	Results	IS standards	
		Desirable limits	Permissible limits
Alkalinity	29.4	200	600
Acidity	34	-	-
Hardness	1.67	300	600
Turbidity	1.1	5	10
pH	5.64	6.5	8.5
Chlorides	17.16	250	1000
DO	0.75	14.6(0^o C) -7 (35^o C)	

We observe that alkalinity, hardness, turbidity, chloride are within the safe limit. The pH of well water is 5.64 which show that water is slightly acidic. The dissolved oxygen present in the water is 0.75 mg/L which is not within the desirable limit therefore aeration is needed.

C.Various Types Of Water Demands

While planning water supply scheme, it is necessary to find out not only the total yearly water demand but also to assess the required average rate of flow and the variations in these rates. It is very difficult to precisely assess the quantity of water demanded by the public,since there are many variable factors affecting water consumption. The various types of water demands, which a city may have, may be broken down into the following classess:

1. Domestic water demands.
2. Industrial water demand
3. Institution and commercial water demand
4. Demand for public uses
5. Fire demand

In order to estimate as correctly as possible, the total water demand of a particular section of the community, all these demands must be considered and suitable provision made, depending upon the needs of those people for whom the water supply scheme is to be designed.

1)Domestic Water Demand

This includes the water required in private buildings for drinking, cooking, bathing, gardening etc. The amount of domestic water consumption per person shall vary according to the living conditions of the consumers. As per IS: 1172-1993,the minimum domestic consumption for a town or a city with full flushing system should be taken at 200l/h/d; although it can be reduced to 135l/h/d for economically weaker section.

2) Industrial Water Demand

The industrial water demand represents the water demand of industries which are either existing or are likely to be started in future in the city for which water supply is being frank. This quantity will thus vary with the number and types of industries present in the city. The ordinary per capita consumption on account of industrial needs of a city is generally taken as 50 litres per person per day, which may suffice only to meet the water demand of small industries.

3)Institutional and Commercial Water Demand

The water requirements of institutions , such as hospitals, hotels,restaurents, schools, officers etc should be accessed and provided for , in addition to domestic and industrial water demand. This quantity will certainly vary with the nature of the city and with the number and types of commercial establishment and institution present in it.

4)Demand For Public Uses

This includes the quantity of water required for public utility purposes, such as watering of public parks, gardening, washing and sprinkling on roads, use in public foundation etc. A nominal amount not exceeding 5% of the total consumption may be added.

D. Population Estimation at the end of the design period

The different methods include:

- Arithmetical increase method
- Geometrical increase method
- Incremental increase method
- Decreased rate of growth method
- Graphical comparison method
- Graphical extension method
- Zoning method
- Ratio and correlation method
- Growth composition analysis

Arithmetical Increase Method

In this method, the increase in population from decade to decade is assumed to be a constant. From the census data of past 3 to 4 decades, the increase in population for each decade is calculated and from that an average increment is determined.

The population at the end of design period is given by

$$P_n = P + ni$$

where, P_n = Population after n decades (population at the end of design period)

P = Present population

n = Number of decades

I = Average increment for a decade

Population Data

The population data of past 4 decades were collected and given in Table 5.1. The future population of the city after 25 and 50 years were calculated. The population after 25 years is 3195715 and 50 years is 4273140.

Table 8.1 – Population Data Of Past 4 Decades

YEAR	POPULATION
1980	8,24,900
1990	11,40,600
2000	15,36,400
2010	21,17,990

Population After 50 Years

Present population = 21,17,990

No. of decades = 5

Average increment in population per decade, I = 4,31,030

Population after 50 years = 21,17,990 + (5 x 4,31,030)

= 42,73,140

.4. CONCLUSION

The various conclusions reached in the first phase of this project include:

- The quality of water presently supplied in Kochi is quite acceptable
- The water demand of the city is in high rise
- Since the entire supply of the city comes from Aluva Water Treatment plant and there is an increasing water scarcity observed, an alternative water supply scheme from Neriyamangalam to Kochi is proposed.

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