WATER BALANCE STUDIES IN VIJAYAWADA & GUNTUR CITIES

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ABSTRACT:

A water budget reflects the relationship between input and output of water through a region. The purpose of a water budget study is to determine if an area's water supplies are adequate to meet current and projected water demands. A water budget study is essentially like assessing a financial account, where you determine how much water is being deposited in an area, how much is being withdrawn, and how much is available for future use. Water budgeting allows for planning and management of water resources in a sustainable manner. The water budgeting study leads to water supply data classification, estimation of collection-supply gap, recyclability, and savings in terms of water quantities and financial savings. The water supply balance studies were carried out for package drinking water plants in Vijayawada, Guntur cities, Vijayawada Municipal Corporation, Guntur Municipal Corporation, Vijayawada railway station, Guntur railway station. It was found from the initial water balance studies that in Vijayawada municipal corporation the water that can be saved without any additional investment is 11,40,000 liters per day.

Key words: water scarcity, water budgeting, water demand, packaged drinking water

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I. INTRODUCTION

Globally, water demand is rising and resources are diminishing. Water is a precious natural national resource with almost fixed quantum of availability. With continuous growth in country's population, per capita availability of utilizable water is going down, whereas with ever-rising standard of living of people, all around rapid industrialization and urbanization, demand of fresh water is going up continuously. Inspite of the fact that fresh water is rapidly becoming scarce it is continued to be used wastefully. Increasing demand and development pressures are changing the characteristics of water in India. Groundwater reserves are becoming more and more depleted as surface water sources become too polluted for human use. At the global level, about 60-70 percent of total annual water consumption is in irrigation sector. In all countries water requirement for domestic and industrial purposes is constantly on the increase. The satisfaction of these requirements becomes increasingly difficult due partly to the limited capacity of water and partly to the ever-growing pollution of the surface and ground water. Already there are acute shortages of both surface and under ground waters in many cities in the world. Due to the

pollution of the streams, lakes and underground water sources has greatly impaired the quality of the water and there by reducing the availability of water quantitatively. Therefore it is utmost important for good conservation and sanitary measures be practiced by everyone.

A. Global Water Crisis

More than two billion people worldwide live in regions facing water scarcity and in India this is a particularly acute crisis. Millions of Indians currently lack access to clean drinking water, and the situation is only getting worse. India's demand for water is growing at an alarming rate. India currently has the world's second largest population, which is expected to overtake China's by 2050 when it reaches a staggering 1.6 billion putting increase strain on water resources as the number of people grows. A rapidly growing economy and a large agricultural sector stretch India's supply of water even thinner. Meanwhile, India's supply of water is rapidly dwindling due primarily to mismanagement of water resources, although over-pumping and pollution are also significant contributors. Climate change is expected to exacerbate the problem by causing erratic and unpredictable weather, which could drastically diminish the supply of water coming from rainfall and glaciers. As demand for potable water starts to outstrip supply by increasing amounts in coming years, India will face a slew of subsequent problems, such as food shortages, intrastate, and international conflict.

B. Water Quantity Crisis

About 70% of the total fresh water available is being used to meet the agricultural demand. The World Water Council believes that by 2020 we shall need 17% more water than the available to feed the world. The World Water Assessment Program (WWAP) reported that another 45 million hectares (111 million acres) will be under irrigation by 2030, requiring an increase of 14% in water used for irrigation (Hopkins, 2000).

School of Public Health (University of California) reported that nearly half a billion people around the world facing the water shortage today. By the year 2025 the number will explode fivefold to 2.8 billion people which are 35% of the world's projected population. In 1996, people used an esteemed 54% of all accessible fresh water that may go up to 70% by the year 2025 (Hinrichsen et. al, 2002). .

A country faces water stress when annual water supplies drop below 1,700 cubic meters per person. Water-scare countries have annual water supplies of less than 1000 m^3 per person. At present, thirty-one countries are facing the stress of water scarcity. By 2025 population pressure will push another 17 countries including India on to the list. China , with a projected 2025 population of 1.5 billion, will not be far behind. Even in the United States, where there is plenty of water on a national basis, in some areas, people are depleting ground water reserves at 25% greater rate than the rate at which nature can replenish.

C. Water Crisis in India

Water crisis is a term used to refer to the world's water resources relative to human demand. The term has been applied to the worldwide water situation by the United Nations and other world organizations. The major aspects of the water crisis are allegedly overall scarcity of usable water and water pollution .The proportion of people in developing countries with access to safe water is calculated to have improved from 30 percent in 1970 to 71 percent in 1990, 79 percent in 2000 and 84 percent in 2004, parallel with rising population. The Earth has a finite supply of fresh water, stored in aquifers, surface waters and the atmosphere. Sometimes oceans are

mistaken for available water, but the amount of energy needed to convert saline water to potable water is prohibitive today, explaining why only a very small fraction of the world's water supply derives from desalination.

There are several principal manifestations of the water crisis.

- Inadequate access to safe drinking water for about 884 million people
- Inadequate access to water for sanitation and waste disposal for 2.5 billion people
- Groundwater over drafting (excessive use) leading to diminished agricultural yields
- Overuse and pollution of water resources harming biodiversity
- Regional conflicts over scarce water resources sometimes resulting in warfare

D. The Causes of the Crisis

Today, the causes of this way of managing water are clearly visible. There is complete dependence on the state for any kind of water provision. It is a kind of fostered parasitism since the state, via its bureaucratic machinery, does not seem to possess the will to alter such a situation. Such has been the level of extraction from rivers that most of India's river basins have degraded and the rivers are polluted. Large dams are the major source of water storage, and canals are the major distributor's route. Groundwater resources have been heavily over-used. Thus water availability, both in terms of quality and quantity, has declined to such an extent that many parts of India, rural and urban, today face a drought-like situation.

E. Future Demand Scenario

Future water demand scenario has 2 broad connotations viz.

(1) Economical and optimal use of fresh water including prevention of wastage / leakage.
(2) Multiple uses (reuse and recycling) of water.

Irrigation will continue to be the bulk consumer of water. Two-third of the food requirement of 450 million tons by 2050 is obtained from irrigated fields. Even with the full development of the estimated ultimate irrigation potential of 139.89 million hectares by 2050 AD only 65% of net sown area will receive irrigation and the balance 35% will still depend on vagaries of the monsoon. Not only that, the ever growing population demanding the fresh water at an enormous rate for their personal use and, to produce the daily needs or things of the people, industries and organizations also in the race.

By viewing all the above factors it is necessary to read the water balance and conduct the water audit. Thus we can know how

(i) The total quantity of water available for consumption
(ii) The total quantity of water that is being supplied for different usages.
(iii) The quantity of water that is utilized properly or effectively, and
(iv) The total quantity of water that is wasted and unaccounted for.

Based on the water balance studies, water conservation and management programs can be evolved and implemented. Because of the present and future water crisis, it is essential to conduct water audits. Keeping in view the need for water balance and audits, an attempt has been made to conduct the preliminary water supply balance studies of some organizations in Vijayawada and Guntur cities.

F. Scope and Objective of the Study

The world's water crisis is so severe that it could take almost 80 years to eradicate hunger. Because of the gap between fresh water demand and availability of water resources the world in general and India in specific, experiencing severe water crisis,. This made us to think about the fresh water resources that are available and how much water has been used, how much water is

saved and how much water is being wasted in industries, domestic and commercial sectors and how much water is being wasted, because of negligence, leakages and thefts.

G. Scope of the Study

In this study we have taken packaged drinking water companies in Vijayawada & Guntur city and water budgeting is carried out. The water quantities received or collected from various water resources for distribution, water losses and effluent water (wastewater) were evaluated for the selected organizations by preliminary water budgeting & water auditing. The water supply data showing the bulk water supply to every house connections has been collected from Vijayawada Municipal Corporation. Water quantities supplied to different units in each organization through distribution, the water losses and water unaccounted at the time of distribution, and recyclable water component from the water wasted after specific usage of water are to be estimated. The water budgeting study leads to water supply data classification, estimation of collection-supply gap, recyclability, and savings in terms of water quantities and financial savings.

H. Objective of the Study

The objective of the study is to suggest a way to local water bodies and households to asses the amount of wastage of water, the quantity of water that can be reused, and unaccountable water by conducting preliminary water balance studies a part of water auditing. By water auditing one can save not only water but also money.

I. Necessity of the study

It has been observed that the water levels in the reservoirs & ground water table are getting dropped, which is due to lack of rains, monsoon, and non-availability of infiltration galleries & also because of seepage losses. This leads to the study of water budgeting & water balance studies in residential & commercial sectors to minimize the water usage**.**

II. WATER CONSERVATION

Rapid industrialization and urbanization coupled with continuous decline in per capita water availability is putting a lot of pressure on the available water resources in the country. As per report of standing sub-Committee for assessment of availability and requirements of water for diverse uses in the country (August, 2000) the future water requirements for meeting the demands of various sections in the country for the year 2025 and 2050 have been estimated to be 1093 BCM and 1447 BCM respectively. The increasing gap between water availability and demand highlights the need for conservation of water. The National Water Policy 2002 also lays stress on conservation of water. It has been stipulated that efficiency of utilization in all the diverse uses of water should be optimized and an awareness of water as a scarce resources should be fostered**.** Process of conservation may be synonymous of preservation against loss or waste. Technically, conservation of water implies the same meaning in a much wider perspective. Briefly stated it means putting the water resources of the country for the best beneficial use with all the technologies at out command. Water conservation basically aims at matching demand and supply. There is a need for water conservation, not only to restore the fast deteriorating eco-system of the country but also to meet the inevitable emergency of shortage even for drinking and domestic water in near future.

Water availability in terms of utilizable water resources in India is 1,122 km^3. Besides this, the quantity of 123 km^3 to 169 km^3 additional return flow will also be available from increased use from irrigation, domestic and industrial purposes by the year 2050. The per capita availability of

utilizable water, which was about 3,000 m^3 in the year 1951, has been reduced to 1,100 m^3 in 1998 and is expected to be 687 m^3 by the year 2050.

III. OBSERVATIONS AND ANALYSIS

The present and future water crisis, it is essential to utilize water resources efficiently and economically thus by saving the water for future purpose, keeping in view the need of water in our daily life and for future generation an attempt has been made to conduct the preliminary water balance studies in Vijayawada and Guntur city by considering the areas where huge amount of water will be needed, such as domestic water demand and railway stations etc.

A. Dr.K.L.Rao Water Works

The total water used in Vijayawada city is drawn from the Krishna River. The water that is sent to city through pumping system Power units: Daily – 3000, Monthly – 9 lakh rupees.

Total capacity of water - 40MGD
Total no. of reservoirs – 44
Total raw water - 371.22 LGD
Pumping water – 341.28 LGD
Waste water - 29.94 LGD

For one month

Raw water = 9208.5 LGM
Pumping water = 8770.0 LGM
Cost of thousand liters = 1.40 paisa
Losses-10%
Power charges for month – 40 lakh rupees

Table-1: Details of VMC water supply position

Present population: 1000000, Source: Krishna River

Installed capacity	52.00 MGD	272.76 MLD
R.g filter	40.00 MGD	181.84 MLD
Present supply from r.g filters	32.50 MGD	150 MLD
Total supply	39 MGD	177.30 MLD
Losses @ 15%	5.85 MGD	26.59 MLD
Per captia supply as per norms	33.15 MGD	150.69 MLD
Water supply coverage	90%	

** **Presently 150.00 LPCD is being supplied to the public against 150 LPCD, at present there is no scarcity of water supply in the city**

Table-2: Details of GMC water supply position

Present installed capacity	122.82 MLD
R.G filter	72.77 MLD
Present supply	7527MLD
Transmission losses	25%
Water made available for distribution	54.95 MLD
Per capita supply	96 LPCD
Water supply coverage	88%
Total power charges paid (pumping)	Rs.28 lakh per month

Every day 75.27 MLD of protected water is being supplied to city approximately 105 liters per head /day is supplied

Table-3: Water Supply Details in Vijayawada, Guntur cities

Item	Vijayawada	Guntur
Total Population	10,00,000	7,00,000
Total Demand (MLD)	272.76	128.82
Actual Supply (MLD)	150	75
per capita supply as per norms	150/135	75/135
Losses	15%	25%
Power Charges by electricity board	1.40 ps	1.40ps
No. of Connections (legal)	78298	62759
Total Coverage (city)	90%	88%
Length of Distribution Network	960 kmts	611kmts

Table-4: List of Mineral Water Manufacturing Units Situated In Municipality Limits

Mineral water manufacturing units situated within municipal limits	Mineral water manufacturing units which are not having BIS Certificate
Name of the Unit	**Yes/No**
Hi-Tech mineral water	**Yes**
Ashoka foundation water plant	**No**
Rajiv Arogya-Sree	**No**
So safe water plant	**No**

PACKAGED DRINKING WATER COMPANIES:

In Vijayawada around 375 packaged drinking water companies exists, out of which many are not having the Municipal Corporation permission or BIS certification. Following table will give the information about the major packaged drinking water companies.

TABLE-5: List of Water Package Drinking Water Plants in Vijayawada

S.No.	Name of the Company	Amount of water supplied (l/day)
1	Hitech	1 LAKH
2	Cristal	1 LAKH
3	Spring	80,000
4	Sprinkle	80,000
5	Tirumala	70,000
6	Wintech	70,000
7	Aquatech	60,000
8	Besco	70,000
9	Model	70,000
10	Badis	70,000
11	Rohini	70,000
12	Nanotech	70,000
13	Subiksha	20,000
14	Suraksha	20,000

15	Attck	20,000
16	Kinely	20,000
17	Vijaya	20,000
18	ABC	20,000
19	Ashoka Fondations	20,000
20	Nagarjuna Foundations	20,000
21	Sindhu	18,000
22	Mr. DOCTOR	8,000
23	Blinz	4,000
24	Rajeev	4,000
25	Health&Wealth Foundations	8,000
26	Sanjeevaa-health Foundations	5,000
27	Venkateswara	5,000
28	Subharaju Foundations	5,000
29	Amrutha	3,000
30	AVR	3,000
31	SO SAFE WATER Plant	7,000
TOTAL		**1,140,000**

TABLE-6: Packaged Drinking Water Plants in Guntur

S.No.	Company name	Amount of water supplied (l/day)
1.	Wisdom	20,000
2.	Hi-Tech	20,000
3.	Dew Drops	10,000
4.	City Mineral Water Works	10,000
5.	Splash	20,000
6.	High Speed	10,000
7.	Jala Dhara	10,000
8.	Gangotri	10,000
9.	King Cool	7,000
10.	METRO	8,000
11.	Sujala AQUA	9,000
12.	DELTA	20,000
13.	Sujalar	10,000
14.	Pearl Drops	20,000
15.	Nice Drops	10,000
16.	Swasthik	10,000
17.	OZONE IZZ	10,000
18.	AVS	10,000
19.	Ravi Drops	10,000
20.	STAR	10,000

21.	Tirumala	20,000
22.	AMULYA	7,000
23.	Vijaya Sangam	40,000
TOTAL		**3, 11,000**

IV. CALCULATIONS

Table-7: Vijayawada Municipal Corporation

Sl.No.	Item	Water quantity
A	Total Water supplied by VMC	272.76 MLD
B	Actual Population	18,15,066.7 NO'S
C	Total Drinking Water	99,82,866.3 l/day
D	Total Packaged Drinking Water	11,40,000 l/day
E	Actual Water to be supplied (C-D)	88,42,866.3 l/day
F	Power Charges	8 crocres/month
G	Power Charges Per Day	2,19,178 Rs/day
H	The Power Charges for 272 MLD	2,19,178 Rs/day
I	The Excess Power charges	3,32,980 Rs/year

Water supplied by VMC = 272.76 MLD = 272260000 liters/day
Population = Total water supply / Percaptia demand
= 27,22,60,000 / 150
= 1815066.66 numbers
Total drinking water supplied = Population X 5.5 liters
= 1815066.7 X 5.5 = 9982866.3 liters/day
Total amount of packaged drinking water = 11,40,000 liters/day
Actual amount of water to be supplied = 8842866.3 liters/day
Power charges paid by VMC per year = 8 crores/year
Power charges per day=2,19,178 Rs/day
The power charges for 272 mld = 2,19,178 Rs/day
The excess money that is paid by VMC through power charges = 3,32,980 Rs/year

Table-8: Guntur Municipal Corporation

Sl.No.	Item	Water Quantity
A	Total Water Supplied by GMC	122.82 MLD
B	Actual Population	17,17,600NO'S
C	Total Drinking Water	47,57,752 l/day
D	Total Packaged drinking water	3,11,000 l/day
E	Actual Water to be supplied (C-D)	44,46,752l/day
F	Power CHARGES	25lakhs/month
G	Power Charges Per Day	93333.33Rs/day
H	Power Charges for 122.2 MLD	93333.33Rs/day
I	The Excess Power Charges	86,262.2 Rs/year

GMC:
Amount of water supplied by GMC = 75 liters/day
Drinking water supplied by GMC = 2.77liters/day

Amount of water supplied by GMC = 122.82 mld
Population = 1717600 numbers
Total drinking water supplied = population X percapita demand
= 1717600 X 2.77
= 4757752liters/day
Packaged drinking water = 3,11,000 liters/day
Actual water to be supplied = 4446752 liters/day
Power charges for 122.82mld = 93333.33Rs/day
Excess power charges for 3,11,000 = 86,262.2 Rs/year

V. SUMMARY AND CONCLUSIONS

In this present work, initial water supply balances were conducted for VIAJAYAWADA, GUNTUR CITY and water consumption or water demand details were collected.

- Vijayawada is drawing water from Krishna River & the installed capacity is 52.00 MGD quantity of water. The total water supplied is 39.00MGD (177.30 MLD). The transmission losses are 15% (5.85 MGD).The percaptia water supply is 33.00 GPCD (150.00 LPCD).presently 150.00 LPCD is being supplied to the public against 150 LPCD. At present there is no scarcity of water supply in the city. The distribution network is available for only 90%of the city area the distribution line is available for 960km length.
- Guntur city is drawing water from Takkellapadu raw water pumping house of 45.50 MLD, Kommamuru canal of 27.27 MLD and from infiltration galleries 4.55 MLD. The total installed capacity is122.82 MLD. The total water supply is 75.27 MLD. The transmission losses are 25%.the water available for distribution are 54.95 MLD.The per captia water supply the city is 96 LPCD.The total power charges paid on pumping units is Rs 28 lakh per month. The entire city population is being supplied potable water. But the distribution net work is available for only 88 % of the city area. The distribution lines are available for only 611 KM length.
- In vijayawada there are 375 package drinking water plants .VMC is supplying drinking water 150 MGD.

VI. CONCLUSIONS

Hence the study of water balance and water budgeting gives the information regarding the usage and losses of water. Based on the information the following conclusions are made:

- The initial capacity of water drawing from Krishna River in the Vijayawada city is & 52.00 MGD. The total water supplied is 39.00MGD (177.30 MLD). The transmission losses are 15% (5.85 MGD). The percaptia water supply is 33.00 GPCD (150.00 LPCD).presently 150.00 LPCD is being supplied to the public against 150 LPCD.
- At present there is no scarcity of water supply in the city. The distribution network is available for only 90%of the city area the distribution line is available for 960km length.
- Guntur city is drawing water from Takkellapadu raw water pumping house of 45.50 MLD, Kommamuru canal of 27.27 MLD and from infiltration galleries 4.55 MLD. The total installed capacity is122.82 MLD. The total water supply is 75.27 MLD. The transmission losses are 25%.the water available for distribution are 54.95 MLD.

- The percaptia water supply the city is 96 LPCD. The total power charges paid on pumping units is Rs 28 lakh per month.
- The entire city population is being supplied potable water. But the distribution net work is available for only 88 % of the city area.
- The distribution lines are available for only 611 KM length.
- The supply of packaged drinking water for Vijayawada city is 11,40,000 litres/day.
- The supply of packaged drinking for Guntur city is 3,11,000 litres /day.
- The total drinking water supplied by VMC is 9, 98,266.3 liters/day and amount of water from GMC is 4, 75,7752litres/day.
- The excess water from VMC is 8842866.3litre and from GMC is 4446752litres/day.
- Therefore the present study reveals that VMC and GMC is drawing excess of water than required.

VII. REFERENCES

1. K. Satish Kumar, Dr.S.Bala Prasad, "Estimation of Water Losses & Savings at some Organizations in Visakhapatnam using Water Balance Studies", Nature and Environment and Pollution Technology (an International Quarterly Science Journal), Vol.8, No.1, pp. 160-170, 2009.
2. T.M.Narasimhan "A note on India's water budget and evapotranspiration", *J. Earth Syst. Sci.* 117, No. 3, June 2008, pp. 237–240, 2008.
3. Sharvil Shah, "Water Audit-Need of the Hour", BIS seminar, 2009.
4. Water Loss Audit Manual for Texas Utilities – by Texas Water Development Board
5. ."Water Supply Program-Water Audit Guidance – AWWA manual M36 Water Audit and Leak Detection", Maryland Department of the Environment, 2002.
6. "Water Supply Program-Conducting a State Facility Water Audit", Maryland department of the Environment, 2002.
7. "Water Conservation – 2001", Maryland Department of the Environment's water Supply program, 2001.
8. "Emerging Fresh Water Crisis in India", a report published by UNICEF, 2001.
9. "Environment and Water India 2000", 3rd Annual International Exhibition, Conference & Festival – New Delhi, 2000.
10. Ernst Schmidt, "Water Recycling and Reuse" 2000.
11. "Water Crisis looms as World population Grows", Hopkins report, The Johns Hopkins University, School of Public Health, 2000.
12. Jagatheesan, et.al, "Improvement in Industrial Environmen Through Water Auditing", 2000.
13. Narian V., "India's Water Crisis: Avenues for Policyand Institutional Reform",TERI information Monitor on Environment Science 2000.
14. James, p. and Mclntyre "Industrial Water Reuse and Wastewater Minimization", 1998.
15. Schroder Milk Co., St. Paul, Minnesota, "Water Production and Product Conservation", 1996.
16. Simmons and Trevor, "Recycled Water at port Warath Coal Terminal", Recycled Water Seminar Proceedings, 1994.