



Experimental Study on Evaporation Losses from an Artificial Reservoir in Rajkot, Gujarat, India

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Abstract: Water is a vital element for all living organisms. Evaporation from reservoir surfaces causes significant water losses, especially in semi-arid regions of India. This study evaluates evaporation losses from an artificial reservoir located in Ghanshyam Nagar, Rajkot, Gujarat, based on one year of field observations (January–December 2014). Water depth was measured using a calibrated level staff three times daily, and meteorological data such as temperature and rainfall were collected from reliable sources. Data analysis using Microsoft Excel revealed that evaporation losses were highest during summer, particularly in May, and lowest during winter. These findings highlight the influence of seasonal temperature variations on evaporation and emphasize the importance of water conservation strategies.

Index Terms: Evaporation Loss, Artificial Reservoir, Water Storage Tank, Seasonal Variation, Temperature Effect, Water Conservation, Rajkot.

I. INTRODUCTION

Water is the most essential requirement for survival of all living entities, and life cannot exist without it. It plays a crucial role in the development and growth of individuals, societies, cities, and nations. In India, water losses due to evaporation are significantly high. Evaporation is the process by which molecules of a liquid escape from its surface and change into vapor at a temperature below its boiling point. It is generally measured in terms of depth of water or % of volume of water.

According to the report of the Central Water Commission (CWC, 1990), the average annual evaporation from reservoirs and other water bodies in India ranges from more than 450 mm to more than 3000 mm across the various region of India. Moreover, according to estimates reported by the Central Water Commission and the National Commission for Integrated Water Resources Development, the total evaporation loss from reservoirs and other freshwater storage bodies in India is approximately **27,000 million cubic meters (MCM) per year**, which may increase to about **56,000 MCM annually** with the expansion of storage capacity in the future. These substantial losses highlight the need for effective reduction of evaporation and water conservation measures in all freshwater storages of India. If true data of evaporation losses are available then we can take further action including research study for saving the water.

2. OBJECTIVES OF STUDY

The main objectives of this study are:

1. To measure the evaporation losses from an artificial water storage tank through field observations.
2. To analyse the effect of seasonal variations (summer, monsoon, and winter) on evaporation losses.
3. To study the relationship between temperature and evaporation rate.
4. To estimate the percentage of water loss due to evaporation throughout the year.

3. LITERATURE REVIEW

Evaporation from open water bodies such as reservoirs, lakes, and storage tanks is a significant component of the hydrological cycle and represents an important source of water loss in water resource systems. In regions with high temperatures and strong solar radiation, evaporation losses can substantially reduce the effective storage capacity of reservoirs and tanks. Therefore, understanding the factors affecting evaporation losses is essential for efficient water resource management. Studies conducted by the Central Water Commission reported that evaporation losses from reservoirs and water bodies in India vary significantly depending on climatic conditions, geographical location, and the characteristics of the reservoir. The average annual evaporation from reservoirs in India ranges from 500 mm to 3250 mm, indicating that evaporation contributes considerably to water loss from surface storage systems.

The Food and Agriculture Organization highlighted that evaporation losses are particularly high in arid and semi-arid regions, where factors such as high temperature, solar radiation, and wind velocity increase the evaporation rate. In such regions, evaporation may account for a substantial portion of the total water loss from reservoirs.

Several researchers have studied the influence of meteorological parameters on evaporation. Research by Gundalia M. J. and Dholakia M. B. analyzed evaporation behavior in the Junagadh region of Gujarat and reported that temperature, humidity, wind speed, and atmospheric pressure significantly affect evaporation rates on a daily and seasonal basis.

Other studies have examined the effect of physical characteristics of reservoirs on evaporation. According to Barnes G. T., evaporation losses from reservoirs are influenced by factors such as surface area, depth of water, and exposure of the water surface to environmental conditions. Larger exposed surface areas generally result in higher evaporation losses.

Research on evaporation from lakes and reservoirs by Ferhat G. showed that evaporation losses from surface water bodies can represent a considerable portion of stored water, particularly during periods of high temperature and low humidity. Similarly, studies by Assel R. and co-researchers on lake evaporation processes demonstrated the importance of climatic factors and water surface characteristics in determining evaporation rates.

Although many studies have focused on evaporation losses from large reservoirs and natural lakes, relatively limited research has been conducted on small artificial storage tanks, especially in urban environments. Artificial tanks may experience different evaporation characteristics due to variations in depth of water, surface area, and exposure conditions.

Therefore, the present study focuses on evaluating evaporation losses from artificial water storage tanks located in Rajkot. The study aims to analyze the effect of water depth, surface area, and seasonal temperature variations on evaporation losses, thereby contributing to improved understanding of water loss from small storage systems and supporting better water resource management practices.

4. Methodology / Materials and Methods.

4.1 Study Area: The present experimental study was conducted on an artificial reservoir located at Ghanshyam Nagar in the western part of Rajkot, in the state of Gujarat. Rajkot is situated in the semi-arid region of western India at approximately 22.30° N latitude and 70.78° E longitude. The climate of the region is characterized by high temperatures during summer, moderate rainfall during the monsoon season, and relatively mild winters, which makes it suitable for studying seasonal variations in evaporation.

The required data for the study were collected through direct field observations at the reservoir site and from reliable secondary sources such as the Central Water Commission, Basin Planning and Management Organization, Rajkot Municipal Corporation, and meteorological information obtained from AccuWeather.

The specification of artificial water reservoir is given below,

- Reduced Level of the floor on which the tanks are placed is 135.04 m.
- Length and Breadth of the Tank1 are 1760 mm and 950 mm respectively.
- Latitude and Longitude are 22.2822° and 70.7596° respectively.
- Depth of the Tank is 650 mm.

The experiment was conducted for a one-year period from 1 January 2014 to 31 December 2014 to capture the seasonal effects of summer, monsoon, and winter on the rate of evaporation.

4.2 Instruments Used:

Various instruments, including a thermometer, calibrated level staff, measuring tape, and measuring cylinder (rain gauge), were used during the experimental observations. The study aimed to analyse the effects of water depth and surface area on the evaporation rate and to estimate the quantity of water loss due to evaporation from the reservoir.

4.3 Measurement Procedure:

The method adopted for measurement during this research work was standardized to ensure accuracy and consistency. The detailed procedure followed during the study is described below:

1. A calibrated level staff was used to measure the depth of water in the storage tank.
2. The water level in the storage tank was measured three times within a 24-hour period using the calibrated level staff.
3. For each day (24 hours), observations were recorded at fixed intervals. The first reading was taken at 6:00 a.m., the second reading at 2:00 p.m., and the third reading at 10:00 p.m. This procedure was repeated daily throughout the study period.
4. The total duration of the study was one year, which allowed the analysis to include the effect of all three major seasons summer, monsoon, and winter on the rate of evaporation.
5. On daily bases data of rainfall and temperatures were also recorded.

A standard metal pan filled with water is placed in an open area near to water storage (let it is referred as tank A) from which evaporation loss need to be measured. The standard PAN is exposed to same natural atmospheric conditions as tank A. The decrease in water level in the pan over a fixed period represents the evaporation loss of Tank A for that duration.

4.4 Data analysis:

The collected data were processed and analysed using Microsoft Excel for the calculation of evaporation losses and for the preparation of graphical representations of the results. Additional computational and analytical assistance tools were used to verify the accuracy of the calculations and to ensure consistency in the data analysis.

At the end of each month, a total of 90 readings of water depth, 60 readings of minimum and maximum temperature, and one rainfall reading were available for analysis. These datasets were systematically organized and analysed to determine the variation in evaporation losses. The results obtained from the analysis are presented and discussed in the subsequent section. Evaporation Losses have been calculated using following formula. Observed and Calculated parameter are listed in the Table 01 for the artificial water reservoir.

Depth of water decreased due to Evaporation DEL

$$DEL = D_s - D_e + D_r$$

Here,

D_s = Depth of water at Start of the Month.

D_e = Depth of water at End of the Month.

D_r = Depth Increased due to Rainfall.

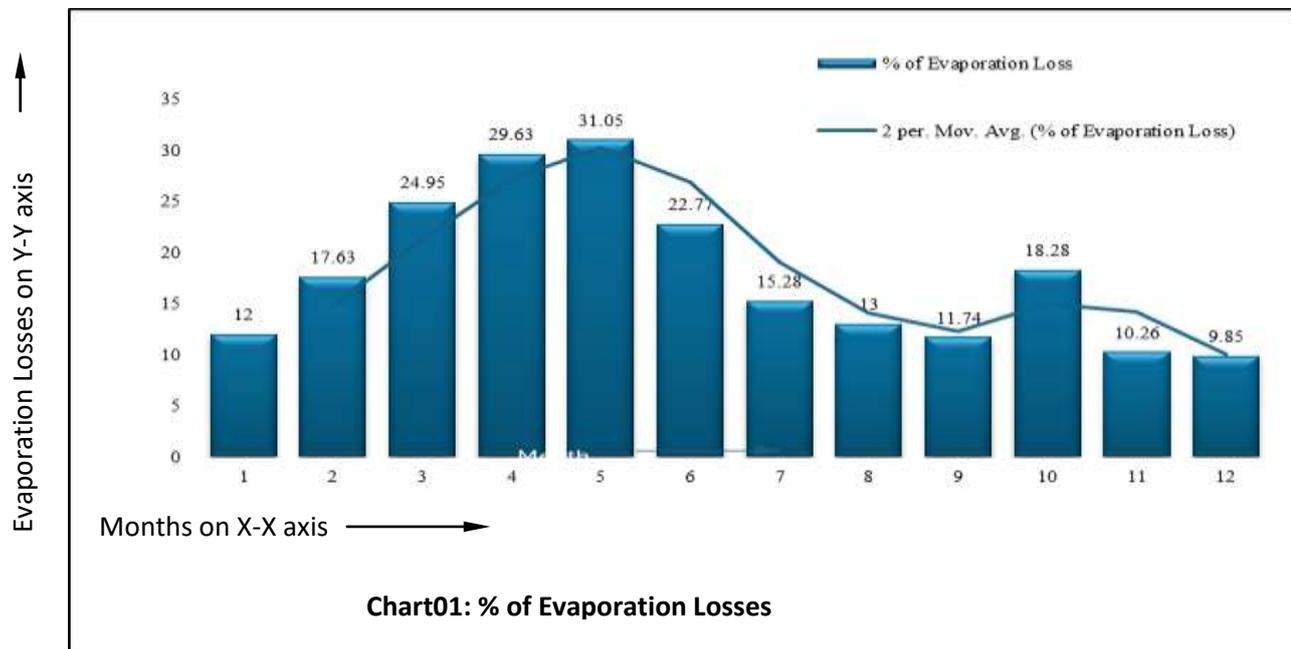
$$\% \text{ of Evaporation Loss } EL = DEL \times 100 / D_s$$

5. Results and Discussion.

Observed and Calculated parameter are listed in the Table 01 for the artificial water reservoir. Chart 01 is also prepared and shown below table01.

Sr. No.	Month	Mean Temp. In °C	Depth of Water (in mm)				% of Evaporation Loss
			At Start of the Month	At End of the Month	Increased due to Rainfall	Decreased due to Evaporation	
1	Jan.	20	500	442.4	2.4	60	12
2	Feb	22.3	442.4	368.7	4.32	78	17.63
3	Mar	26.6	368.7	276.7	0	92	24.95
4	Apr	31	276.7	196.9	2.16	82	29.63
5	May	34	500	353.5	8.75	155.3	31.05
6	Jun	32	439.1	360	20.88	99.98	22.77
7	July	29	360	472.8	185.84	55	15.28
8	Aug	27.8	323	357.7	76.51	42	13
9	Sep	28.15	357.7	383	67.34	42	11.74

10	Oct	28.5	383	350.7	37.72	70	18.28
11	Nov	25.25	350.7	325	10.27	35.97	10.26
12	Dec	21.6	325	300.5	7.5	32	9.85



6. Conclusion

Based on the analysis of the observed data for the year 2014, the following conclusions were drawn:

1. The maximum percentage of evaporation loss during the year 2014 was 29.63%, which occurred in the month of May, when the mean temperature was approximately 34°C, which was the highest recorded during the study period.
2. Although the mean temperature in June was the second highest, the evaporation loss in June was not the second highest, which may be attributed to the higher humidity conditions during the monsoon onset.
3. The minimum percentage of evaporation loss during the year 2014 was 9.85%, which occurred in the month of December.
4. From Chart 01, it is observed that evaporation losses gradually increase from January to May and then decrease from June to December.
5. It can also be concluded that evaporation losses are highest during the summer season and lowest during the monsoon season.
6. The findings of this study highlight the significant impact of temperature and seasonal variations on evaporation losses from artificial reservoirs. Therefore, understanding the pattern of evaporation losses can help in better water resource management and the implementation of appropriate evaporation control measures to minimize water loss from storage tanks and reservoirs

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