



Estimation of Evaporation Losses on Dharoi Dam

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Abstract

In this study, the Evaporation losses at Dharoi dam is studied. The data like temperature, wind speed, relative humidity and pan evaporation are collected and analysis is done taking in account five different methods for computation, those methods are Meyer's method, Rohwer's method, Papadakis method, BlaneyCriddle method, Thornthwaite method and Evaporation rates are estimated using these five different methods. The computed values of evaporation rates are compared with the values of evaporation measured by Pan. The most efficient method is Papadakis method for the period of 2001 to 2014. The average evaporation rate is from Papadakis method evaporation values obtained from the calculation were ranging from 0.15 mm/day to 5.96 mm/day with an average of 3.16 mm/day. These values are near to the Pan Evaporation values. For improving the results of the values of the Evaporation (mm/day) from the different methods. In season wise computation, the Thornthwaite method is suggested for winter season and Papadakis method is suggested for summer and monsoon season. The Correction factors are determined for all the seasons of each method. The Statistical analysis is also done for each method. From statistical analysis, Thornthwaite method is the most efficient method for computing evaporation rate.

Keywords: Evaporation, Papadakis method, BlaneyCriddle method

I. INTRODUCTION

Water is precious gifts of god. The use of water by man, plants and animals is universal. Without it, there can be no life. Every living thing requires water. So water is life. Now a days the use of water is increasing rapidly with our growing population. Already there are acute shortages of both surface and under-ground waters in many parts of the country. Careless pollution and contamination of the streams, like, reservoir, wells, and other under-ground source has greatly impaired the quality of available water. This pollution results because of improper disposal of waste water both domestic as well as industrial.

Evaporation is the process by which water is converted into gaseous state. Evaporation is an important process in the hydrologic cycle preceding precipitation. It is the process by which water in the liquid form transforms into vapour through the transfer of energy. When water is converted from solid state to vapour state without passing through liquid state then it is called sublimation.

Evaporation occurs from the water surfaces of natural and artificial reservoirs, lakes etc., The rate of evaporation is dependent on: (I) The vapour pressures at the water surface and air above, (II) Air and water temperatures, (III) Wind speed, (IV) Atmospheric pressure, (V) Quality of water and (VI) Size of the water body, (VII) Depth of the water in the water body, (VIII) Humidity, (IX) Radiation. The rate of evaporation increases with the increase of temperature as well as with the increase of wind velocity, but it decreases with the increase of humidity as well as with the increase of dissolved salts in water. Further the evaporation increases with the increase in the open surface area of water and soil.

II. STUDY AREA

Dhroi dam is gravity dam on the Sabarmati River near Dharoi, Mehsana, district of northern Gujarat in India. The Sabarmati River originates from the Aravalli hills.

Dharoi Dam is the first major reservoir on the main river. The project envisaged providing irrigation to cropped area in 127 villages of Mehsana District and 50 villages of Sabarkantha District. Dharoi project is a multipurpose project. The main purposes of the project are as under:

- Irrigation
- Supply of drinking water
- Flood protect

The total area proposed to be irrigated was 43320 hectares and the Irrigation water demand was estimated 218.33 MCM. It can be observed during last eleven years the planned irrigation demand of 216 MCM has been exceeded only once (1964-85). On an average about 77% of the planned irrigation demand has been observed.



Fig. 1: Location Map of study area of Dharoi dam



Fig. 3: Image of Dharoi dam

Table 1: Features of site

Location	Village : Dharoi, Disrict : Mehsana
Purpose	Irrigation, Water Supply
River	Sabarmati
Catchment Area	5475 km ²
Mean annual runoff in the catchment	1052 Mm ²
Mean annual rainfall	633 mm
Year of commencement of construction work	1971
Year of completion	1978

III. DATA COLLECTION

To facilitate achieving the objectives to calculate evaporation loss of the study area the climatic data i.e. minimum and maximum temperature, relative humidity, wind speed, sunshine hours, rainfall and reservoir performance data will be collected. Different data will be collected from different agencies. The data will be collected from various government agencies. The various data collected and sources of data are enlisted as follows.

- Climatic data: climate data comprise of major five variables namely, minimum and maximum temperature, relative humidity, wind speed, sunshine hours. These five basic climate dataset are the minimum requirement for planning.
- The above mentioned climate parameter will be available from the metrological stations established in around the area.
- Meteorological data will be collected from States Water Data Centre Gandhinagar.
- Dharoi reservoir data will be collected from executive engineer, Dharoi Irrigation Scheme, Dharoi, Ta. Satlasana, Dist. Mehsana.

IV. METHODOLOGY

By using the collected data, computation of monthly evaporation is carried out using Meyers's formula, Rohwer's formula, Papadakis formula, Thornthwaite formula, BlaneyCriddle formula, Panmen formula and compared with Pan Evaporation Value.

Empirical Equation

Meyer's Equation:

$$E = K_M \left(1 + \frac{U_9}{16} \right) (e_s - e_a)$$

ea = Actual vapour pressure

es = Saturated vapour pressure.

E = Evaporation cm/day.

U9 = Monthly mean wind velocity in km/h at about 9m. above ground.

KM = Coefficient, 0.36 for large deep waters and 0.50 for small,

Actual vapour pressure = es x Relative humidity

Rohwer's Equation:

$$E = 0.771(1.465 - 0.00732P_a)(0.44 + 0.0733U_o)(e_s - e_a)$$

Pa = Mean barometer reading = 750 mm Hg

Thornthwaite Equation:

$$E = (1.6 \left(\frac{10T_a}{I} \right)^{6.75 \times 10^{-7} I^3 - 7.71 \times 10^{-5} I^2 + 1.79 \times 10^{-2} I + 0.49}) \left(\frac{10}{d} \right)$$

Ta = Air temperature

d = Number of days in month

I = annual heat index ($I = \sum i, i = (T_a/5)1.514$)

BlaneyCriddle Equation:

$$E = (0.0173T_a - 0.314) \times T_a \times (D \div DTA) \times 25.4$$

Ta = Air temperature

D = Hours of daylight

DTA = Total annual hours of daylight for specific latitude

Papadakis Equation:

$$E = 0.5625(e_s \text{ max} - (e_s \text{ min} - 2))(10/d)$$

es max = saturated vapour pressure at daily maximum air temperature (Pa)

es min = saturated vapour pressure at daily minimum air temperatures (Pa).

d = Number of days in month

V. RESULT AND DISCUSSION

- Meyer's method evaporation values obtained from the calculation were ranging from 0.84 mm/day to 40.56 mm/day with an average of 4.82 mm/day.
- Rower's method evaporation values obtained from the calculation were ranging from 1.07 mm/day to 34.03 mm/day with an average of 7.03 mm/day.

- Blaney-Criddle's method evaporation values obtained from the calculation were ranging from 0.62 mm/day to 24.3 mm/day with an average of 5.08 mm/day.
- Papadakis's method evaporation values obtained from the calculation were ranging from 0.15 mm/day to 5.96 mm/day with an average of 3.16 mm/day.
- Thornthwaite's method evaporation values obtained from the calculation were ranging from 0.40 mm/day to 13.19 mm/day with an average of 5.33 mm/day.
- Pan evaporation values obtained from the observation were ranging from 0.79 mm/day to 6.50 mm/day with an average of 2.93 mm/day.
- According to values obtained from the previous calculation the best suited method in comparison with the Pan Evaporation value is Papadakis Method. While using Papadakis method evaporation values obtained from the calculation were ranging from 0.15 mm/day to 5.96 mm/day with an average of 3.16 mm/day. These values are near to the Pan Evaporation values. The results that were obtained by various different methods carry out wide variations due to the methods which depend upon various factors.

VI. SUGGESTION OF CORRECTION FACTOR FOR VARIOUS METHODS

Values of evaporation computed by different method in this chapter are compared with the rate of evaporation obtain by pan methods. In order to get the better estimation of evaporation by various method, Correction factor as shown in table 5.8 are suggested. To find out the acceptable value of Evaporation rate (mm/day), the correction factor were been calculated dividing the year into three seasons i.e., winter season (November to February), summer season (March to June) & Monsoon season (July to October). Accordingly various methods are modified.

Computation of Evaporation Using Modified Equation

With the help of these Pan corrected factors applied for all the 5 different methods, calculation of the modified evaporation values are done and compared with the Pan Evaporation values.

Using Papadakis's method evaporation values obtained from the calculation were ranging from 0.138 mm/day to 6.841 mm/day with an average of 2.933 mm/day, in Rohwer's method evaporation values obtained from the calculation were ranging from 0.492 mm/day to 13.362 mm/day with an average of 2.928 mm/day, from Meyer method evaporation values obtained from the calculation were ranging from 0.289 mm/day to 30.2819 mm/day with an average of 3.019 mm/day, whereas from BlaneyCriddle method evaporation values obtained from the calculation were ranging from 0.349 mm/day to 12.373 mm/day with an average of 2.929 mm/day, and even Thornthwaite method evaporation values obtained from the calculation were ranging from 0.387 mm/day to 6.989 mm/day with an average of 2.932 mm/day

According to the calculations done for the evaporation before and after the modification all the six methods gave different values and varied ones at the beginning before the modifications were done, whereas after modification all the six methods gave the values near about the same as Pan Evaporation value. By this it can be concluded that modified methods are giving better estimation of evaporation.

Estimated of values of evaporation by existing different method and modified methods are used for regression analysis.

VIII. RESULT AND CONCLUSION

In this report it was planned to study Evaporation losses at Dharoi dam. The data like temperature, wind speed, relative humidity and pan evaporation were collected and analysis were done taking in account six different methods for computation, those methods are Meyer's method, Rohwer's method, Papadakis method, BlaneyCriddle method, and Thornthwaite method. Evaporation rates are estimated using the six different methods i.e., Meyer's method, Rohwer's method, Papadakis method, BlaneyCriddle method, and Thornthwaite method the computed values of evaporation are compared with the values of evaporation

measured by Pan. On the basis of their comparison the Evaporation value of the Papadakis method were nearly similar to that of the Pan Evaporation value, whereas, the other four methods including Meyer's method, Rohwer's method, BlaneyCriddle method, and Thornthwaite method were over estimated. So, on the basis of the calculation, Papadakis method showed a good Evaporation rate compared to others.

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REFERENCES

- Chavez, J.L., Gowda P.H., Howell T.A., Evapotranspiration Mapping Using METRIC for a Region with Highly Advective Conditions ASABE Annual International Meeting, 2007
- Donald O. Rosenberry, Thomas C. Winter, Donald C. Buso and Gene E. Likens (2007), "Comparison of 15 evaporation methods applied to a small mountain lake in the north-eastern USA", Journal of Hydrology (2007) 340, 149– 166.
- Gorjizade A., Ali M.A, Zarei H., Kaboli H.S., Evaluation of Eight Evaporation Estimation Methods in a Semi-arid Region (Dez reservoir, Iran) International journal of Advanced Biological and Biomedical Research, Volume 2, Issue 5, 2014: 1823-1836.
- Gundalia M. J., Dholakia M. B., Dependence of evaporation on meteorological variables at daily time-scale and estimation of pan evaporation in Junagadh region, American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-02, Issue-10, pp-354-362