

# Estimation of Evaporation

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**ABSTRACT:** Water evaporation is one of the obscure components of hydrologic cycle to measure accurately. There are two basic reasons for this obscurity. First one is the direct method and second one is indirect method. In direct method, measurement of evaporation is made by using water budget technique, Lysimeter and Pan Evaporation method. In indirect method, estimation of evaporation is made by Aerodynamic method, Energy budget method, Penman equation, Blaney Criddle method, Jensen Haise method, Hargreaves method. But it is observed that none of the above method gives true measurements of evaporation. Also, none of the above mentioned methods used for estimation of evaporation are universally accepted. Estimation of reliable or acceptable value of evaporation requires either a reliable instrumentation or a judicious application of climatic and physical data.

The objective of this paper is to select a method, which provides possibly realistic estimate of evaporation, and to derive pan coefficients, which may be useful to get reliable estimate of evaporation. The other objective of this paper is to find the factors affecting rate of evaporation such as wind velocity and humidity.

**KEYWORDS:** Evaporation, Pan Coefficient, Estimate of Evaporation.

## I. INTRODUCTION

Evaporation is the important element of hydrological cycle. True estimate of evaporation is difficult in various regions. There is no record of evaporation in Konkan region. Therefore, it is very difficult to select a site for evaporation station. In this study, we select the site, which is near to the river which flows from the campus of Dr. Babasaheb Ambedkar Technological University, Lonere, District Raigad, which is located at the foothills of Sahyadri Ranges. There are two different methods of estimation of evaporation.

### A) Direct Method

#### i. Water budget technique:

This technique involves the maintenance of a water budget. Mathematically it is stated as

$$E = I - O \pm \Delta S$$

E = Evaporation

I = inflow into soil reservoir

= Irrigation water + precipitation + incoming soil water contribution from surrounding + G.W

O = deep percolation (inside soil runoff)

$\Delta S$  = Change in storage

$$\text{Now } I = i + P + SFI + SSQ + GW$$

$$O = RO + SSQ + DP + L + E$$

#### ii. Lysimeter:

A lysimeter is a measuring device, which can be used to measure the amount of actual evapotranspiration which is released by plants, usually crops or trees. By recording the amount of precipitation that an area receives and the amount lost through the soil, the amount of water lost to evapotranspiration can be calculated.

Monolithic weighable lysimeters are a tool for water balance studies and solute transport determination.

Lysimeters are of two types:

1. Weighing
2. Non-weighing
- iii. Pan evaporation

(1) USWB Class A Evaporation Pan

A pan of diameter 1210mm and depth 255mm. Depth of water is maintained between 18 and 20cm. Pan is made of unpainted GI sheet. It is placed on a wooden platform of height 15cm above ground level to allow free air circulation below the pan. Evaporation is measured by measuring the depth of water in a stilling well with a hook gauge

(2) ISI Standard Pan

Specified by IS: 5973 and known as the modified Class A Pan, whose diameter is 1220mm and depth is 255mm. It is made of copper sheet 0.9mm thick, tinned inside and painted white outside. It is placed on a square wooden platform of width 1225mm and height 100mm above ground level to allow free air circulation below the pan. A fixed-point gauge indicates the level of water. Water is added to or removed from the pan to maintain the water level at a fixed mark using a calibrated cylindrical measure. The top of the pan is covered with a hexagonal wire net of GI to protect water in the pan from birds. Presence of the wire mesh makes the temperature of water more uniform during the day and night. Evaporation from this pan is about 14% lower as compared to that from an unscreened pan.

(3) Colorado Sunken Pan

920mm square pan made of unpainted GI sheet, 460mm deep, and buried into the ground within 100mm of the top. Main advantage of this pan is its aerodynamic and radiation characteristics are similar to that of a lake and disadvantage is difficult to detect leaks, expensive to install, extra care is needed to keep the surrounding area free from tall grass, dust etc.

(4) USGS Floating Pan

A square pan of 900mm sides and 450mm deep. Supported by drum floats in the middle of a raft of size 4.25m x 4.87m, it is set afloat in a lake with a view to simulate the characteristics of a large body of water. Water level in the pan is maintained at the same level as that in the lake; leaving a rim of 75mm. Diagonal baffles are provided in the pan to reduce surging in the pan due to wave action. Disadvantages of this pan are high cost of installation and maintenance and difficulty in making measurements.

B) Indirect Method

i. Aerodynamic method or Mass Transfer Method

Numerous empirical formulas have been derived which express evaporation as function of atmospheric element. But mostly they are based on Dalton's Law and are given as follows.

$$E = C [e_s - e] f(u)$$

C = Constant

$e_s$  = SVP

$e$  = AVP

$u$  = Wind speed

ii. Energy budget method:

$$R_n = E + A + S + C$$

$R_n$  = Net radiation available energy from sun

$E$  = energy used by evaporation

$A$  = Energy used in heating air

$S$  = Energy used in heating water

$C$  = Energy used in heating the surrounding of water.

iii. Penman equation:

It is combination of aerodynamics and energy budget equations.

Purpose of this research was to estimate the true evaporation of the area. This was done by installing evaporimeter in the water body of the river. In addition, the check the difference in evaporation of water body and ground surface same setup was installed on the ground near to the river.

The main application of this study was to find out the pan coefficient of our evaporimeter and the factors on which the rate evaporation depends.

## II. LOCATION AND MATERIAL USED

A. Location: The location of raingauge station was in the University campus, the Latitude and Longitude is 18.16° N and 73.32° E respectively. The site is nearly 2 km from the National Highway 17 (Mumbai–Goa).

B. Evaporimeter: Evaporimeter was made of PVC pipe of diameter 105 mm and height of 300 mm whose bottom end closed with the help of cap of same material and upper end kept open. To achieve economy it was suggested PVC pipe as pan.

C. Thermometer: Outside and inside temperature of river water body and ground setup was measured by digital thermometer.

D. Anemometer: It is used to measure wind velocity. It is made up from five three-ounce paper cups (such as Plastic Cups), paper hole punch or sharpened pencil, ruler, two wooden sticks, thread, candle, timer, ball bearing.

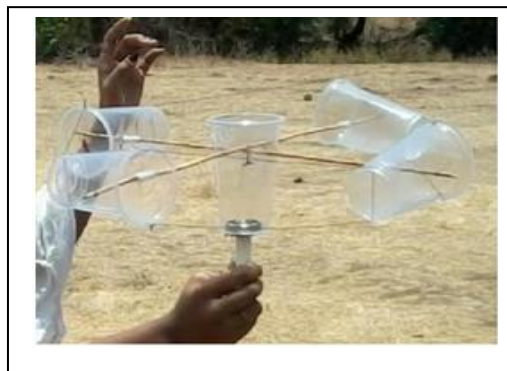
## III. INSTALLATION OF EVAPORIMETER



(a)Evaporimeter Installed in Water body and at Ground Surface

## IV. METHODOLOGY

Pan technique was used to made evaporimeter and for making of Anomometer following method was adopted.



(b) Anomometer

- Take a single-hole cup and push a wooden stick through the hole until about one inch of the wooden stick is inside the cup. Make sure the stick is horizontal and fix it to the side of the cup. Repeat this with another single-hole cup and stick.
- Push the empty end of each stick into one of the side holes in the five-hole cup and out the one across from it. Turn the cups so that they face the same direction.
- Push the empty ends of each stick protruding from the fifth cup into the other two single-hole cups until about one inch of the stick is inside each cup. Turn the new cups so all the bottoms of the cups face the same direction. Fix the ends of the sticks to the side of each cup like you did for the first two cups.
- After making sure all cups are about the same distance from the centre of the five-hole cup, carefully tie the sticks with the help of thread where they intersect, in the middle of the five-hole cup.
- Push the candle through the hole in the bottom of the five-hole cup; this is serve as stand for Anemometer.
- The anemometer is now ready to measure wind speeds.

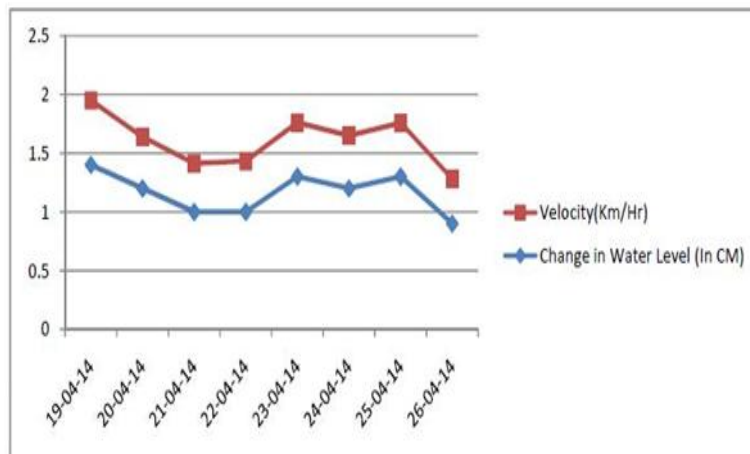
#### V. EXPERIMENTAL PROGRAM

To measure the evaporation, initially evaporimeter was filled with water up to certain height e.g. 250 mm and this assembly emerged into water body taking consideration of water depth and second setup on the ground surface. Reading was taken at 8:00 a.m. and second reading was taken at 5:00 p.m. Difference in water level in the evaporimeter gives the evaporation.

In addition, wind velocity was measured with the help of anemometer. Readings of wind velocity are tabulated below:

Date	In water body (level diff.)	At ground level (level diff.)	Date	Outside Temp. in °C	Change in water level in cm	No. of Rotation (Avg)	Velocity (km/hr)
19/04/2014	0.6	1.4	19/04/2014	38.75	1.4	17	0.55
20/04/2014	0.5	1.2	20/04/2014	37	1.2	13.75	0.44
21/04/2014	0.5	1	21/04/2014	36.12	1	13	0.41
22/04/2014	0.6	1	22/04/2014	37.7	1	13.25	0.432
23/04/2014	0.6	1.3	23/04/2014	41.2	1.3	14.25	0.46
24/04/2014	0.6	1.2	24/04/2014	38.67	1.2	13.75	0.45
25/04/2014	0.6	1.3	25/04/2014	37.45	1.3	14	0.458
26/04/2014	0.6	0.9	26/04/2014	38.5	0.9	11.75	0.38

**VI. GRAPHICAL REPRESENTATION**



(C) Graph: Change in water level at ground and water set up

**VII. CONCLUSIONS**

Readings obtained from evaporimeter of both places were compared and it was found that there is more evaporation at ground as compare to water body. From the observation of reading the rate of ground evaporation is nearly double that of river setup, hence

1. Actual Evaporation (In River body) =  $0.5 \times$  Evaporation ground
2. Rate of evaporation is directly proportional to Wind Velocity. If speed of wind increases the rate of evaporation also goes on increases and vice versa.

**REFERENCES**

[1] Estimation of evaporation losses from water surface – A Study of Tawa Reservoir by National Institute of Hydrology Jalvigyan Bhavan, Roorkee. (1996-97)

[2] H.M. Raghunath, Textbook of Hydrology, New Age International Publication, 2<sup>nd</sup> edition.

[3] IS 5973 (1998): Pan Evaporimeter.

[4] IS 6939 (1992): Methods for determination of evaporation from reservoirs [WRD 10: Reservoirs and Lakes]

[5] J. Tanny, S. Cohen, S. Assouline, F. Lange, A. Grava, B. Telch, M.B. Parlange, D. Berger “Evaporation from a small water reservoir: Direct measurements and estimates

[6] J. Tanny, S. Cohen, D. Berger, B. Telch, Y. Mekhmandarov, M. Bahar, G.G. Katul, and S.Assouline “Evaporation from a reservoir with fluctuating water level: Correcting for Limited fetch