Evaporation and Transpiration:

Evaporation

Evaporation is the process whereby water molecules move from a liquid Phase to a gas phase in response to energy absorbed by the water molecules. The rate of evaporation is governed by three things:

1. The amount of energy.
2. The difference in concentration of water molecules contained in the adjoining air mass.
3. The maintenance of a pressure differential.

Factors affecting evaporation:

1. Temperature;
2. Humidity;
3. Wind;
4. Solar Radiation.

Evapotranspiration: if the ground covered with vegetation, it is impossible to diffrenciate between evaporation and transpiration. The two processes are linged together and referred to Evapotranspiration.

Evapotranspiration= evaporation+ transpiration.

Potential Evapotranspiration (PE): The Evapotranspiration when water supply is unlimited.

Potential Evapotranspiration (P_E):

1. Estimation of P_E from E_o

$P_E = 0.6 * E_o$ [Nov.-Feb.]

$P_E = 0.7 * E_o$ [March-Apr.]

$P_E = 0.8 * E_o$ [May-Aug.]

$P_E = 0.7 * E_o$ [Sep.-Oct.]

E_o : actual evaporation

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2. Thornth waits formula:

$$J=\sum(t_n/5)^{1.514}$$

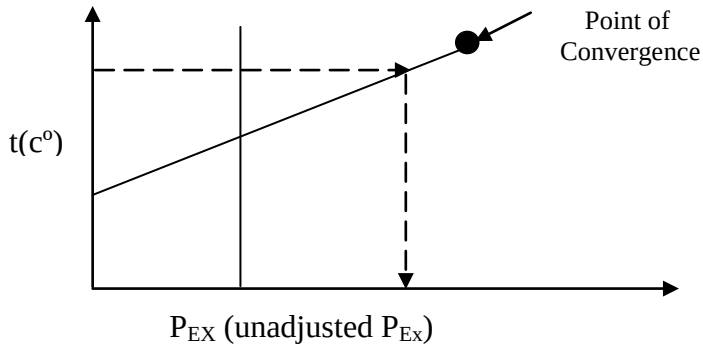
Where:

J=heat index;

t_n=av. Monthly temp.

n=1,2,3,….,12

حيث انه بعد حساب قيمة J من المعادلة السابقة يتم استخراج (P_E) لأي شهر ذو معدل درجة حرارة شهرية (t) باستعمال المخطط الخاص.



t(c°)	P_{Ex}
26.5	135
….	….
…..	….
….	….
38	195

$$P_E = P_{Ex} * (D*T/360) \quad \text{(mm)}$$

Where:

D=number of days in the month;

T=av. Number of hours between sunrise and sunset in month.

Steps of solution:

1. Compute J;
2. Draw straight line from J through point of convergence;
3. Read of the P_{Ex} value corresponding to mean temp.
4. Compute P_E.

3. Evapotranspiration (ET) (Lysimeter)

- Evaporation + Transpiration
- Transpiration : Loss of water through small openings (stomata) of the leaves
- A lysimeter is a measuring device which can be used to measure the amount of evapotranspiration released from an area
- A lysimeter is a tank of soil in which vegetation is planted that resembles the surrounding ground cover
- The amount of evapotranspiration from the lysimeter is measured by means of a water balance of all inputs and outputs
- The precipitation on the lysimeter, the drainage through its bottom, and the changes in the soil water content within the lysimeter are all measured
- The amount of evapotranspiration is the amount necessary to complete the water balance

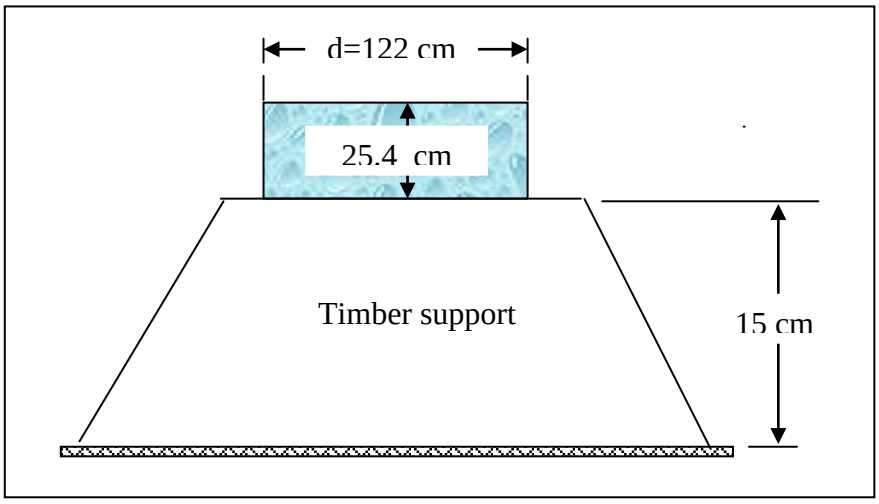
4. Blaney-Criddle method.

Direct Measurments of E_o:

Pan Evaporation:

هي اوعية تحتوي على الماء وتكون معرضة مباشرة للجو حيث يقاس E_o في فترات منتظمة مع الاخذ بنظر الاعتبار تأثير العوامل الجوية كالرطوبة وحركة الرياح ودرجة الحرارة بالنسبة للماء والهواء.

1. American (Class A) Pan (circular):

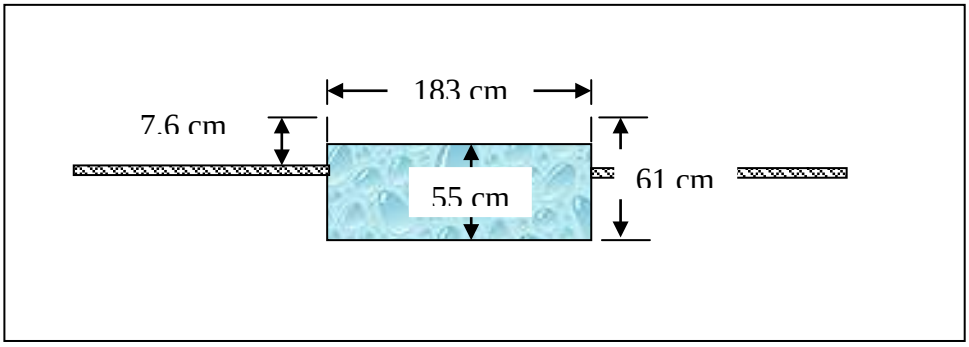


- Evaporation can be measured using a standard evaporation pan called a Class A pan
- Pan evaporation integrates the effects of several climate elements: Temperature, humidity, solar radiation, and wind

- A Class A pan is cylindrical with a diameter of 12 ft (122cm) and a depth of 10 inches (25.4 cm)
- The pan rests on a carefully leveled base and is often enclosed by a fence to prevent animals drinking from it
- Evaporation is measured daily as the depth of water (in inches) that evaporates from the pan

The measurement Pans Starts with 8 inches filled daily as soon the level goes down below 7 inches .Difference in levels= evaporation(precipitation addition should be considered)

2. British Pan (square):



Measurement

- Pan evaporation values are higher than the actual lake evaporation
- $E_o = E_{actual} = E_{pan} * K$
- K = Adjustment factor
- K ranges from 0.64 to 0.81 (for British Pan)
- Average Value = 0.7 (for Class A Pan the U.S.)

Exampl$_1$:

Determine the evaporation from a free water surface, using the Pennman eq. Nomogram for the following cases:

Locality	Month	Temp. (c^o)	h %	n/D	U_2
Amsterdam, 52° N	July	18	0.5	0.5	1.2
Seattle, 47° N	Jan.	4	0.8	0.3	2.5

Solution:

1. $[(941-892)/20] = y_1/8 \Rightarrow y_1 = 19.6$

   RA=19.6+892

   =911.6

   E_o=-2.67+4.3+1.3+1

   =3.93 mm/day

2. $[(49)/20] = y_2/13 \Rightarrow y_2 = 31.85$

   RA=31.85+892

   =923.85

   E_o=-1.13+2.38+0.4+0.42

   =2.05 mm/day

Example 2:

Use the Nomogram for the solution of Pennman eqs. To predict the daily P_E from a field crop at Latitude=40° N in April, under the following conditions:

Mean temp. =20 c^o;

Mean relative humidity=70%;

Sky cover=60% cloud;

Mean u_2=2.5 m/s ;

Ratio of potential evapo-transpiration to potential evaporation=0.7

Solution:

n/D=40%

RA=847

E_o=-2.45+3.58+0.49+1

=2.62 mm/day

P_E=0.7*2.62

=1.83

Exampl$_3$: Determine the evaporation from a free water surface, using the Pennman eq. Nomogram for the following cases:

Locality	Month	Temp. (c^o)	h %	n/D	U_2
Equator	May	15	0.65	0.75	0.5
83^o S	Feb.	15	0.65	0.75	0.5

Solution: