***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.

***Methods of Estimating Evaporation:***

1. Water – Budget (storage) equation;

2. Energy – Budget equation;

3. Penman's Theory.

**1. Water – Budget (storage) equation:**

 Eo=P+I-(O+Og)+(S1-S2)

 تعطي صورة كاملة لكميات المياه الداخلة والخارجة إلى جابية معينة

 Where:

 Eo=**e**vaporation;

 P=**p**recipitation;

 I=surface **I**nflow;

 O=surface **O**utflow;

 Og=sub-surface seepa**g**e ;( it is difficult to measure seepage)

 S=**S**torage.

**2. Energy–Budget equation:** based on the law of energy conservation

هذه الطريقة تتطلب عددا كبيرا من الأجهزة والأدوات حيث أنها تحتاج إلى معلومات كثيرة وتلك المعلومات لا تكون متوفرة آنيا وعليه فإنها طريقة اختصاصية.

**3. Penman's Theory:**

 Data required for the solution of Penman's eq.:

1. Temperature (**t**);

2. Angot value of solar radiation depending on latitude;

3. Relative humidity (**h**);

4. Wind speed at (**2m**) above the ground surface (**u2**);

5. Cloudiness ratio = (**n/D**)

 = (actual hours of sunshine/possible hours of sunshine)

**t E1 n/D**

 **E1 =?**

t a1  n/D E2 RA

**E2=?**

t a2 h E3 n/D

**E3=?**

t a3 u2 E4  h

**E4=?**

Eo= E1+ E2+ E3+ E4

Eb(bare soil)= 0.9\* Eo(open water)

-------------------------------------------------------------------------------------

**Potential Evapotranspiration (PE):**

1. Estimation of PE from Eo

PE =0.6\* Eo [Nov.-Feb.]

PE =0.7\* Eo [March-Apr.]

PE =0.8\* Eo [May-Aug.]

PE =0.7\* Eo [Sep.-Oct.]

------------------------------------------------------------------------------------------------------------------------------------

**2. Thornth waits formula:**

J=∑(tn/5)1.514

 Where:

 J=heat index;

 tn=av. Monthly temp.

 n=1,2,3,….,12

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

Point of

convergence

t(cº)

PEX (unadjusted PEx)

|  |  |
| --- | --- |
| PEx | t(cº) |
| 135 | 26.5 |
| …. | …. |
| …. | ….. |
| …. | …. |
| 195 | 38 |

 PE= PEx\*(D\*T/360) (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 PEx value corresponding to mean temp.

4. Compute PE.

 3. Blaney-Criddle method.

4. Lysimeter (soil container).

-------------------------------------------------------------------------------------

**Direct Measurments of Eo:**

*Pan Evaporation:*

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

**1. British Pan (square):**

183 cm

7.6 cm

55 cm

61 cm

**2. American (Class A) Pan (circular):**

d=122 cm

18 cm

15 cm

Timber support

Eo=Pan coeff.\*Pan evaporation

Pan coeff.=0.92 British Pan

 =0.75 Class A Pan

**Exampl1:**

 Determine the evaporation from a free water surface, using

 the Pennman eq. Nomogram for the following cases:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| U2 | n/D | h % | Temp. (cº) | Month | Locality |
| 1.2 | 0.5 | 0.5 | 18 | July | Amsterdam, 52º N |
| 2.5 | 0.3 | 0.8 | 4 | July | Seattle, 47º N |

**Solution:**

 1. [(941-892)/20] =y1/8 y1=19.6

 RA=19.6+892

 =911.6

 Eo=-2.67+4.3+1.3+1

 =3.93 mm/day

 2. [(49)/20]=y2/13 y2=31.85

 RA=31.85+892

 =923.85

 Eo=-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 PE from a field crop at Latitude=40º N in

 April, under the following conditions:

 Mean temp. =20 cº;

 Mean relative humidity=70%;

 Sky cover=60% cloud;

 Mean u2=2.5 m/s ;

 Ratio of potential evapo-transpiration to potential evaporation=0.7

Solution:

 n/D=40%

 RA=847

 Eo=-2.45+3.58+0.49+1

 =2.62 mm/day

 PE=0.7\*2.62

 =1.83