Precipitation

Precipitation is the general term for all forms of moisture emanating from clouds and falling to the ground, from the time of its formation in the atmosphere until it reaches the ground.

1-Forms of precipitations:

1-1.Rain: المطرdrops usually greater than 0.5 mm in dia. it may reach 6 mm.

1-2-Snow:الثلج is precipitation in the form of ice crystals resulting from sublimation(water vapor directly to ice) and its density =0.1 gm/cm³.

1-3-Drizzle رذاذ: water drops under 0.5 mm dia.

1- 4-Glaze:ice الصقيعcoating formed when drizzle or rain freezes as it comes in contact with cold objects on the ground.

1-5-Sleet:(قطقط) شفشافfrozen raindrops cooled to the ice stage while falling through the air at freezing temperature.

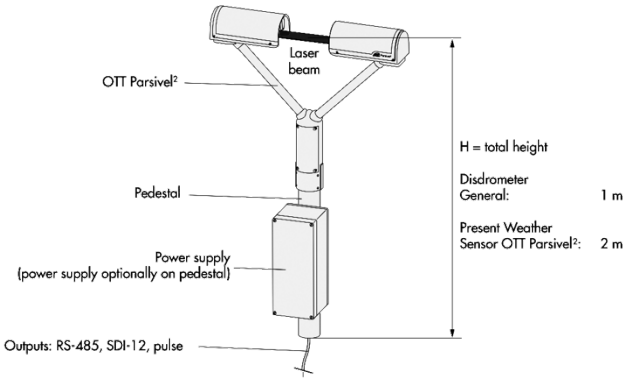
1-6-Hail: البردprecipitation in the form of balls of ice over 8 mm.

1-7-Storm: heavy rains

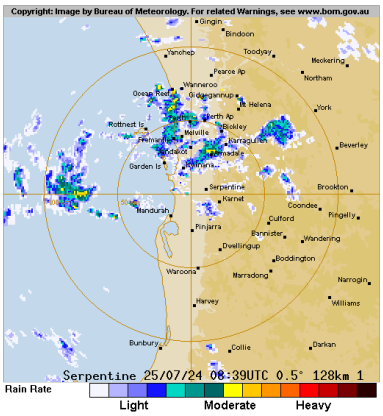
2-Measurement of Precipitation

A variety of instruments and techniques have been developed for gathering information s on various phases of P .

2- 1-Disdrometer - precipitation characteristics



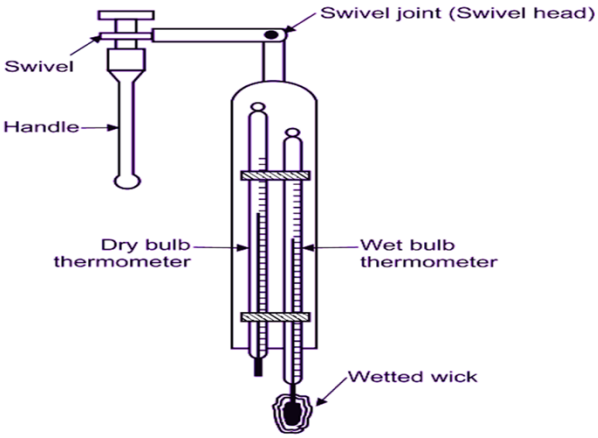
2- 2-Radar - cloud properties, rain rate estimation, hail, and snow detection



2- 3-Rain gauge - rain and snowfall

2- 4-Satellite - rainy area identification, rain rate estimation, land cover/land-use, soil moisture

2-5-Sling psychrometer– humidity



All forms of P is measured on the base of the vertical depth of water that would accumulate on a level of the surface if the P remained where it fell.

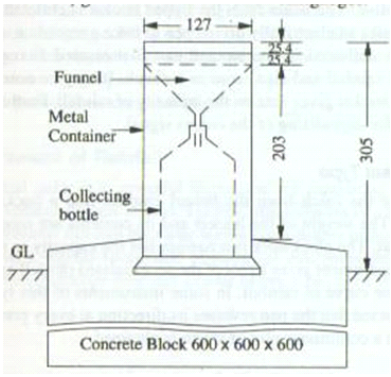
3-Types of rain gauges

3-1-Non-recording rain gage
3-2- Recording gage

Hydrology

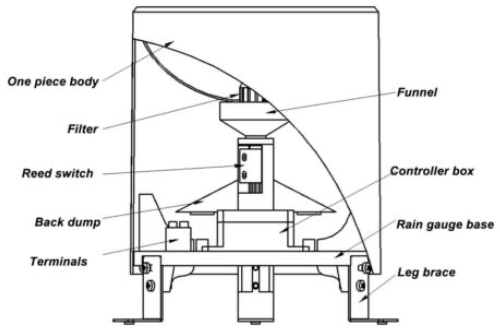
3-1-Non recording gauge

Any open receptacle with vertical sides it is a pan and a collector inside the pan with 12 cm dia. And 30 cm depth and it is scaled to read the water high ,when there is a snow the collector is removed from the pan.

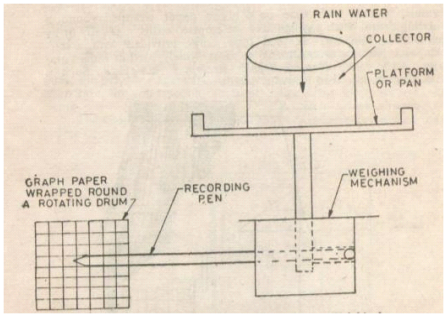


3-2-Recording gauge

a-Tipping bucket gauge



b-Weighing bucket gauge



((The distribution of rain gauges depends on meteorological and topographical Factors))

4-Estimating missing data

Many rain gage stations have a short break in their record because of the absences of the observer because of instrumental failures .here it is necessary to *Estimate the missing record .*

If the normal annual P at each adjacent station is within 10% of that of the station with the missing record ,a simple arithmetic average of the P at the index station provides the estimated amount .

If the average annual P at any of the adjacent stations differs from that at the station by more than 10% the normal ratio method is used.

Nx: the average annual P @ missing station.

Ni: the average annual P @ other stations.

Px: the missing data sta.

Pi: data for other stations.

For checking

$N_i-N_x/N_x \leq 10\%$

$P_X \frac{p_{1+}p_2+p_3+\cdots}{n}$

$N_i-N_x/N_x > 10\%$

$P_x= \left(\frac{N_x}{n}\right)\left(\frac{P_1}{N_1}+\frac{P_2}{N_2}+\frac{P_3}{N_3}+\ldots\ldots\right)$

.n: number of adjacent stations

Examples

Ex.1

The normal annual P of five stations (A,B,C,D &E)are respectively (125,102,76,118,137)cm during a storm the P recorded for stations (A,B,C,&D) are (13.2,9.2,6.8, &10.2)cm , estimate the missing data @ sta. E?

Check

$\frac{125-137}{137} = |0.08| < 0.1$

$\frac{102-137}{137} = |0.255| > 0.1$

Use the normal ratio method.

$$P_x = \left(\frac{N_x}{n}\right)\left(\frac{P_1}{N_1} + \frac{P_2}{N_2} + \frac{P_3}{N_3} + \ldots\ldots\right)$$

$$P = \frac{137}{4}\left(\frac{13.2}{125} + \frac{9.2}{102} + \frac{6.8}{76} + \frac{10.2}{118}\right) = 12.72 \text{ cm}$$

5-Average precipitation over an area:

5-1-**Simple arithmetic mean**

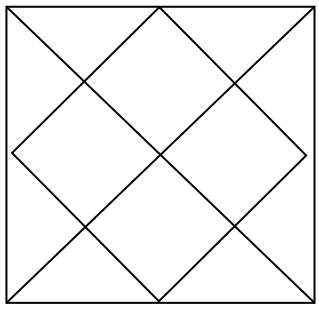
This method is used for a flat ,wide and small number of gages

Pav.=(p1+p2+p3+……+pn)/n

5-2-**Thiessen method**

This method is used at a flat(or nearly), uniform distribution and the area takes a geometrical shape

$P_{av.} = \frac{P_1 A_1}{A_t} + \frac{P_2 A_2}{A_t}$



5-3-**Isohyetal method**

When the arrangement of stations is non-uniform and the area is not flat (like a mountain)with a lot of gages this method is used

Hydrology

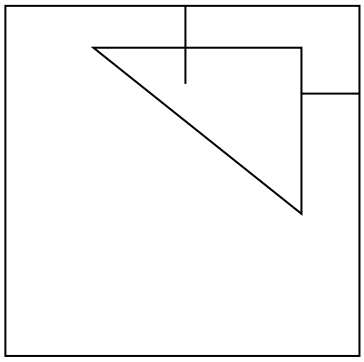
$$Pav.=\left(\frac{P_1+P_2}{2}\right)*\left(\frac{A_1}{A_T}\right)+\left(\frac{P_2+P_3}{2}\right)*\left(\frac{A_2}{A_T}\right)+\ldots\ldots\ldots$$

Ex.2

Asquare area of 100 km² is gauged by three rainfall gauges @ 2.5 km from sides (fig.) estimate the average precipitation?

Sta.	1	2	3
P(mm)	106	152	127

A1=square +triangular
=5*5+0.5*5*5
=37.5 km²=A3
A2=5*5
=25 km²
At=10 *10 = 100 km²
Pav.=(p1(A_1)+P2(A_2) +P3(A_3)) /A_t
=(106*37.5+25*152+127*37.5)/100
=125.4 mm



Ex.3

Isohyets drawn for a storm gave the following data

P(cm)	15-12	12-9	9-6	6-3	3-1
Area(km²)	92	128	120	175	85

Estimate the average precipitation over the catchment.?

$$Pav.=\left(\left(\frac{15+12}{2}*92\right)+\left(\frac{12+9}{2}*128\right)+\left(\frac{9+6}{2}*120\right)+\left(\frac{6+3}{2}*175\right)+\left(\frac{3+1}{2}*85\right)\right)/600=7.4\ cm$$

Ex.4 (H.W)

Compute the value of average P, by Thiessen´s method.?

Gage	Precipitation (in)
1	27.2
2	28.1
3	33.7
4	29.3
5	41.3
6	41.1
7	25.6
8	23.9
9	38.7
10	40.7
11	24.6