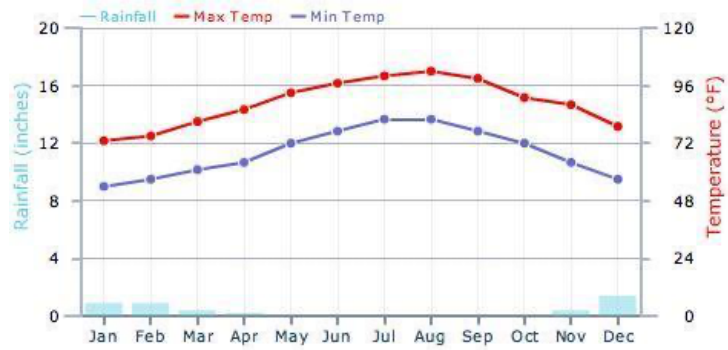
Rainfall information

Climate data pass through several stages in quality control which occurs over some time. Data are only included in this product if no errors have been detected. Data which have not yet completed the routine quality control process are marked accordingly



1-Some definitions related to the rainfall information:

1-1-Intensity(i):

It is a measure of the quantity of rainfall during a given time

$$i=p/t=(mm/hr.)$$

1-2-Duration (t):

It is a period of time during which rain falls. (Hr, second…)

1-3-Frequency(N):

This refers to the expectation that a given depth of rainfall will fall in a given time such an amount may be equal to or exceeded in a given number of days or years.

I.e. how many times during the 10 years the rain falls more than normal.

1-4-Return period(T):

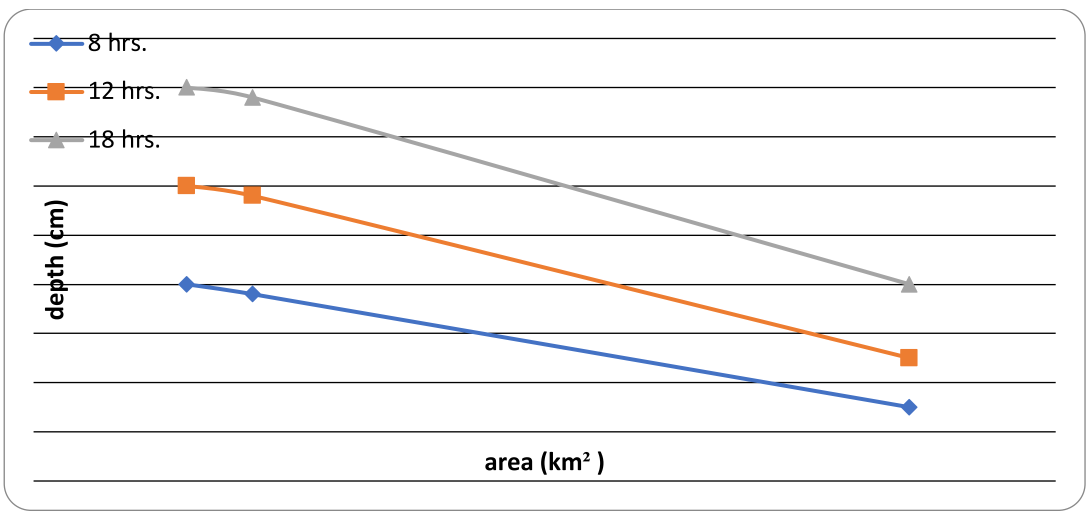
The average period within which rain of a given depth will equaled or exceeded once.

This means it will last for a long period (40 years). How many times is the up-normal amount of rainfall frequent?

2-Relations between rainfall information

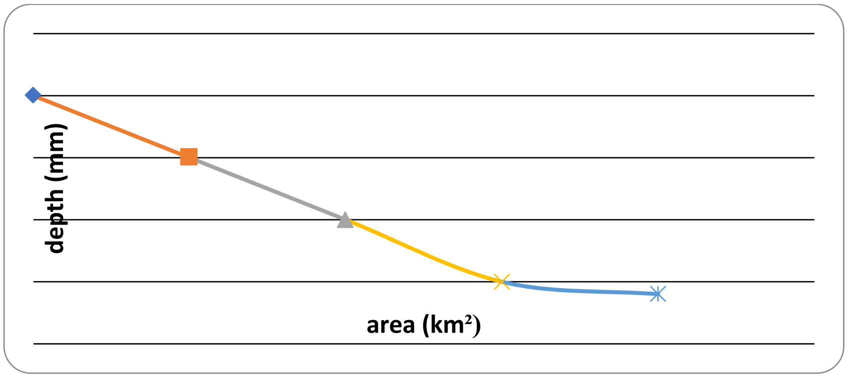
2-1.Depth –Area –Duration (D-A-D)

The relation between the depth of rainfall and the area of the catchment is diversified by time (this means within time the depth increases but when the area increases the depth decreases)



The depth of rainfall in the center of the catchment is the maximum rate and it decreases with the area, increasing (at area =0, P =maximum)

The following curve represents the formula below, and it is also the relation between the depth and the area:

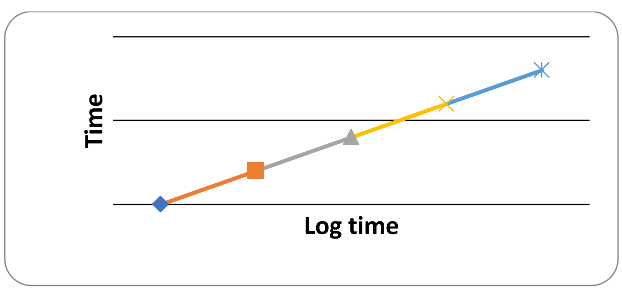


$$\frac{P'}{P} = 1 - \frac{0.3 * \sqrt{A}}{t^*}$$

Where P: average depth

P point depth at the center (mm)

t* inverse gamma function



Hydrology

Ex1:

What is the average rainfall intensity over an area =5 km², during one one-hour storm, if t*=5.6 & i=23 mm/hr.?

P=I * t

=23*1=23 mm

$$\frac{P'}{23} = 1 - \frac{0.3*\sqrt{5}}{5.6}$$

p′=20 mm , i=20 /1 =20 mm/hr.

2-2.Intensity -duration relation

The relation between the intensity & the duration takes the formula

$I=\frac{a}{t+b}$ when t≤ 2 hr.

$I=\frac{c}{t^n}$ when it> 2 hr.

Where a, b, c, and n are constants

When two variable situations are x & y values are measured and a relation between these two is determined. The relation can be linear. Assume a linear or nonlinear does exist and is given by

$$y' = a + bx + \varepsilon$$

y′, x variables

a, b constants and ε error

Constants may be obtained from many methods like the least square method and matrix

Using the least square method to find a, b, c& n

1-Write the equation by the formula of straight line eq.

$Y=Ax+B$

2- $\sum y=A\sum x+NB$

$\sum X=A\sum X^2+B\sum x$

3After solving the last two equations simultaneously

$A=\frac{\sum xy-Nx'y'}{\sum x^2-Nx'^2}$
$B=y'-Ax'$
$x'=\sum\frac{X}{N}$
$y'=\sum\frac{Y}{N}$

Ex.2

Given the relation between the intensity and the duration $i=\frac{a}{t+b}$ Calculate the variables a & b depending on the following data

I(mm/hr)	30	20	15
T(min)	20	40	60

y=Ax+B

$\therefore y=\frac{1}{i}$ x= t A= a $B=\frac{b}{a}$

T=x	y=1/i	xy	x^2
20	0.033	0.667	400
40	0.05	2	1600
60	0.0167	1	3600
∑120	∑0.0997	∑3.67	∑5600

$x'=\sum x/N=40$

$y'=\sum y/N=0.05$

$$A=\frac{\sum xy-Nx'y'}{\sum x^2-Nx'^2}$$

A=0.00083

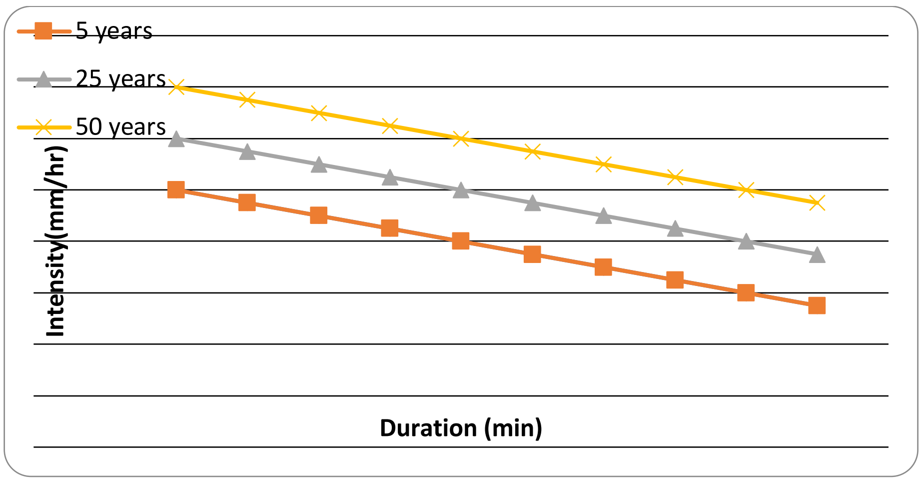
B=0.05-0.00083*40=0.0167

a=1/A=1200 b=a*B=20

$\therefore I=\frac{1200}{i+20}$

2-3Intensity- duration –frequency(IDF)

Structures designed to control stormwater volumes and flows need quantitative criteria to determine their size. Two important stormwater parameters, intensity, and duration, can be statistically related to a frequency of occurrence. The graphical representation of this relationship is the intensity-duration-frequency (IDF). The (IDF)curve is a plot of average rainfall intensity versus rainfall duration for various frequencies of occurrence shown in (fig.) below



Within the time the intensity decreases for any frequency, this curve can be expressed as the following formula: I=Where:

I : intensity(mm/hr.)

T: frequency(yr.)

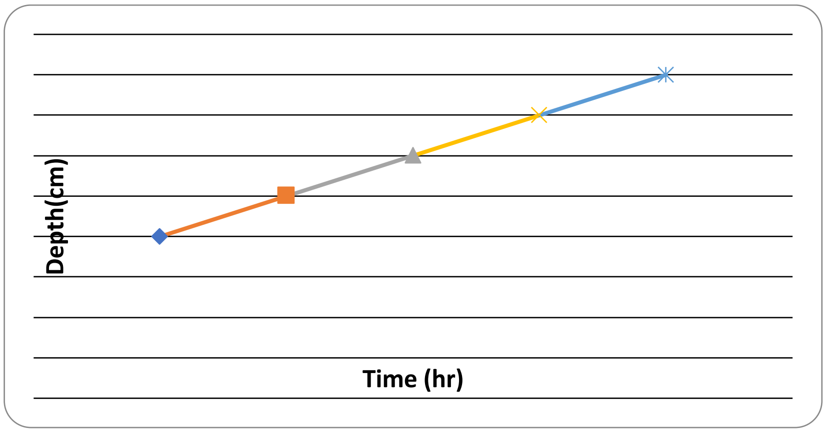
T: duration(hrs.)

A,b, m, & n coefficient varying from one region to another

The common form of the last equation used for hydrologic analysis is one that fixes the frequency of occurrence, thus we eliminate t and m from the equation and assume the exponent n to equal unity resulting in :

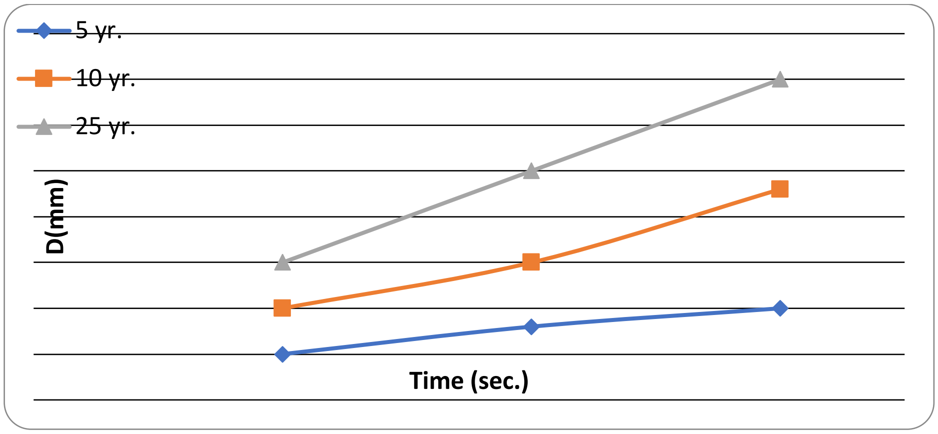
$I=\frac{a}{b+t}$

Also over time the depth increase as it is shown in Fig.

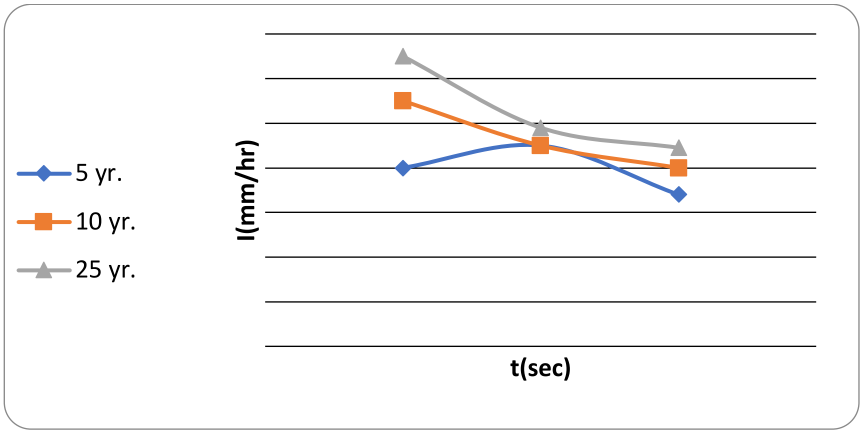


Example: Drive the IDF curve from the data below and find intensity for duration 6 sec., and frequency 5 yrs.?

T(yr.) t(sec)	5	10	15
5	0.4	0.82	1.03
10	0.56	0.9	1.21
25	0.67	0.98	1.35



T(yr.)/ t(sec)	5	10	15
5	0.08	0.082	0.068
10	0.11	0.09	0.08
25	0.13	0.098	0.09



**There are other formulas that connect the depth, duration, frequency & return period one of them is the Bilham formula as follows

$$N=\frac{10}{T}=1.214*10^{5}\ t\ (p+2.54)^{-3.55}$$

N: no. of occurrence in 10 yrs. T: return period , P: depth, T : duration

Ex.3:

Determine the rainfall intensity (cm/hr.) for 40 years. return period storm occurred during 30 min. On 10 10-hectare watershed, what is the volume of water applied in this area?

$=1.214*10^{5}\ t\ (p+2.54)^{-3.55}$

$P=(\frac{1.214*10^{5}}{10})^{1/3.55}\ -2.54$

$=\frac{1.214*10^{5}}{10}*40*)^{1/3.55}\ -2.54=30.3\ mm$

$I = p/t\ =\frac{30.3}{30/60}=60.6\ mm/hr.$

$Vol.=30.3*10^{-3}*10*10^{4}\ =3034.3\ m^{3}$