LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.20
Ed = 81.1646

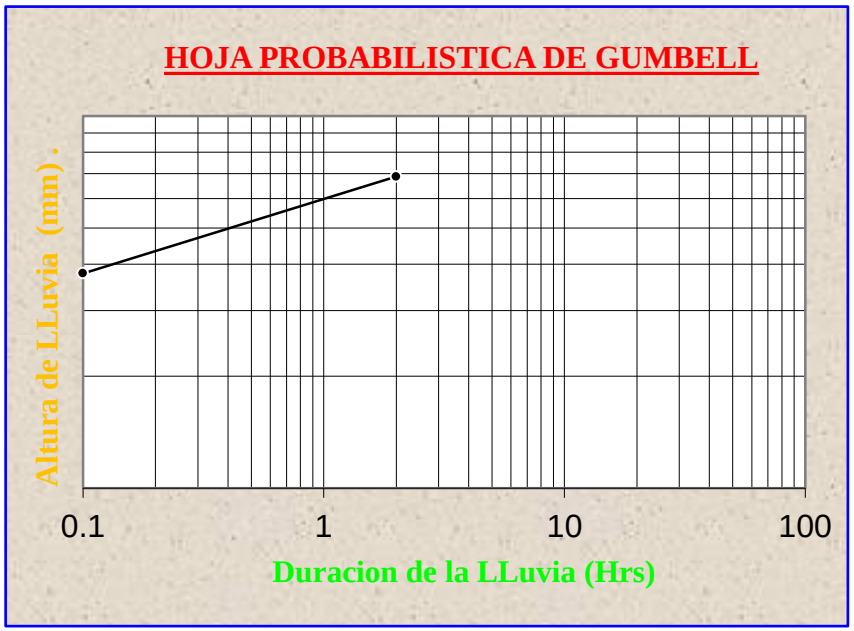
α = 12
Kd = 0.7045

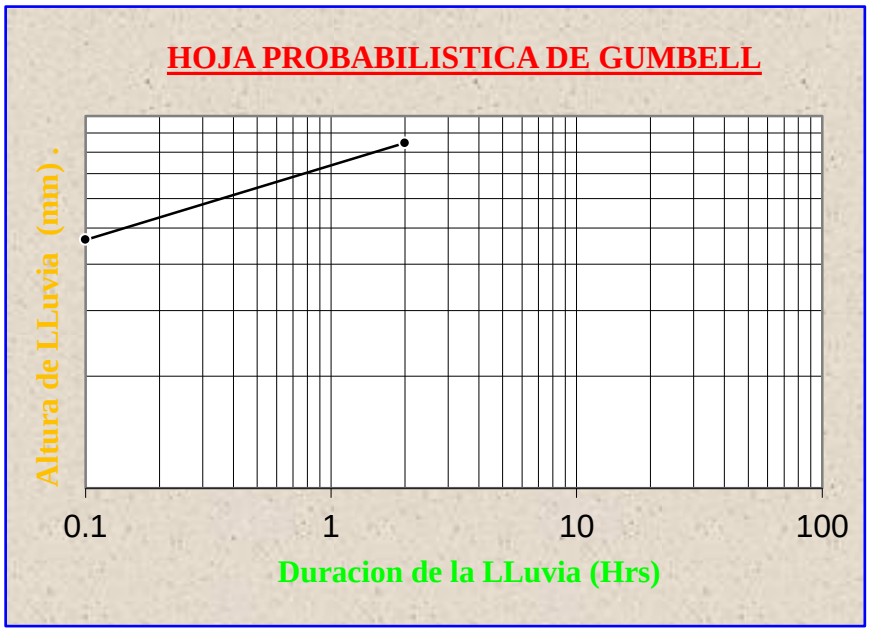
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE BERMEJO

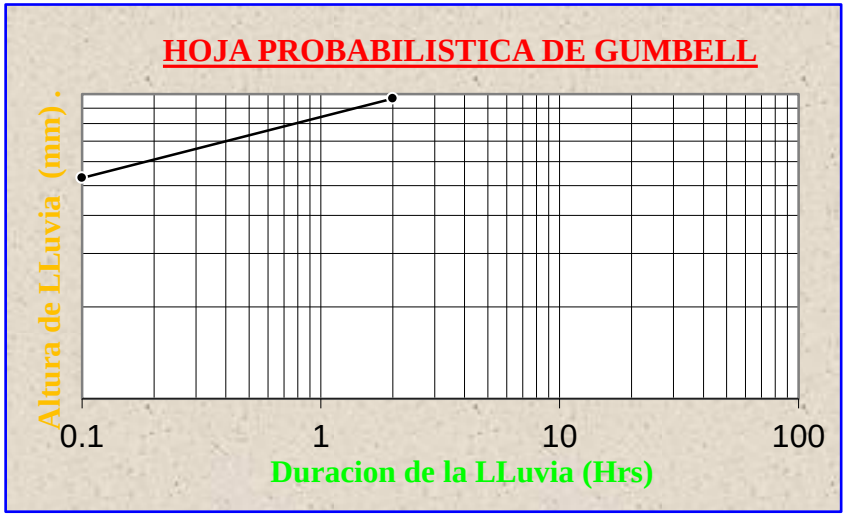
T (años) =	2
t (Hrs)	HtT (mm)
0.1	37.762
2	68.749

T (años) =	5
t (Hrs)	HtT (mm)
0.1	46.497
2	84.650

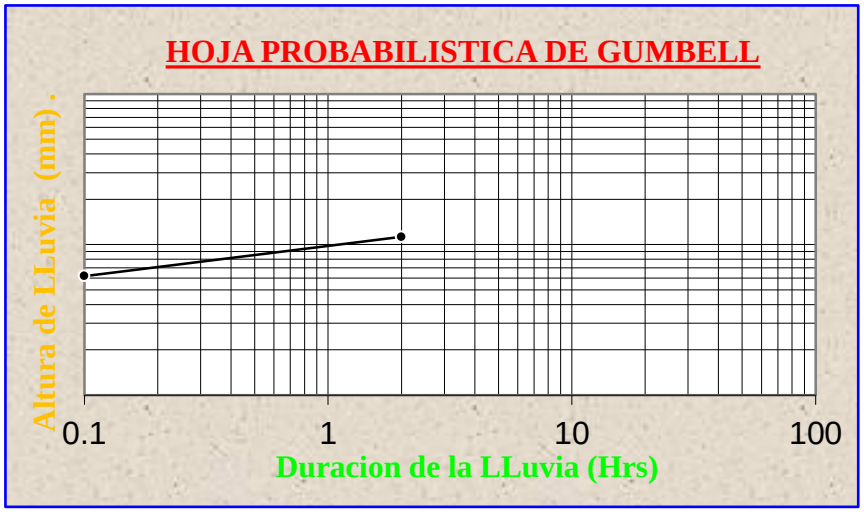




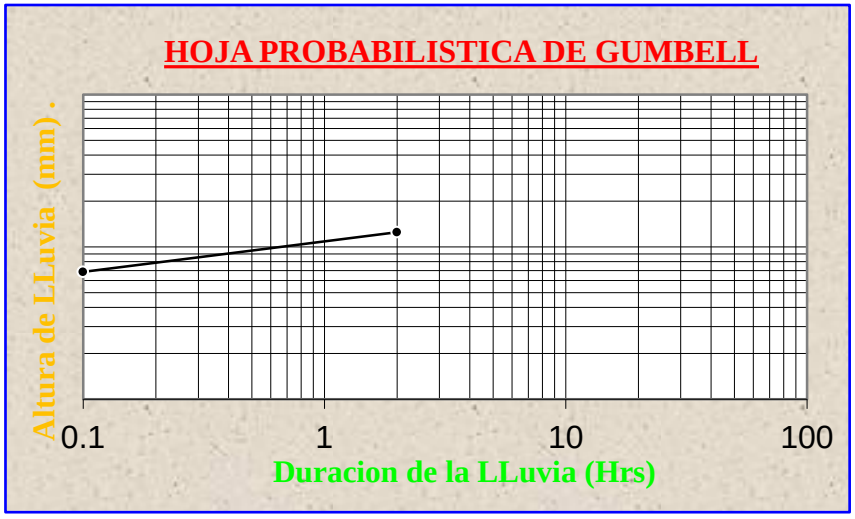
T (años) =	10
t (Hrs)	HtT (mm)
0.1	53.104
2	96.679



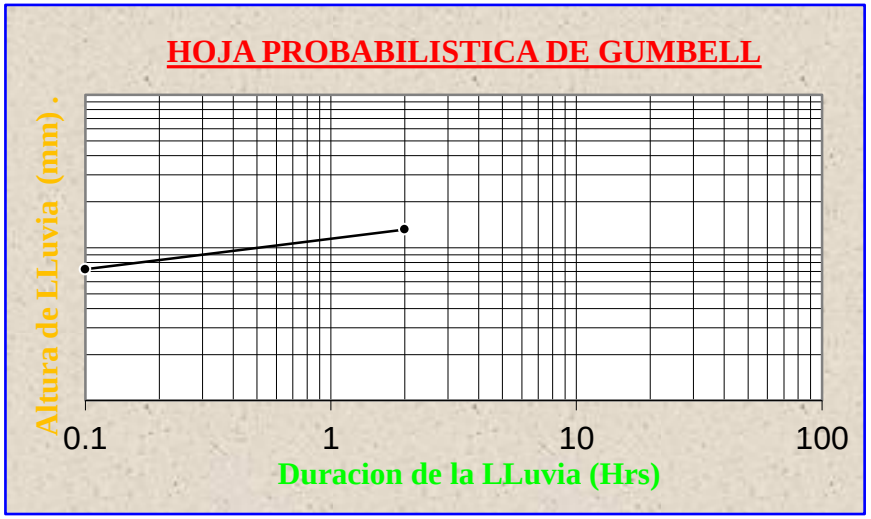
T (años) =	25
t (Hrs)	HtT (mm)
0.1	61.838
2	112.581



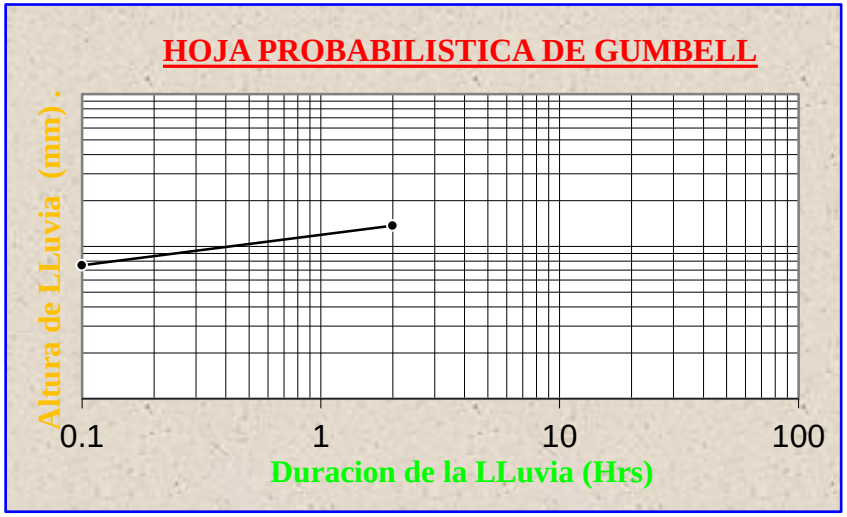
T (años) =	50
t (Hrs)	HtT (mm)
0.1	68.446
2	124.610



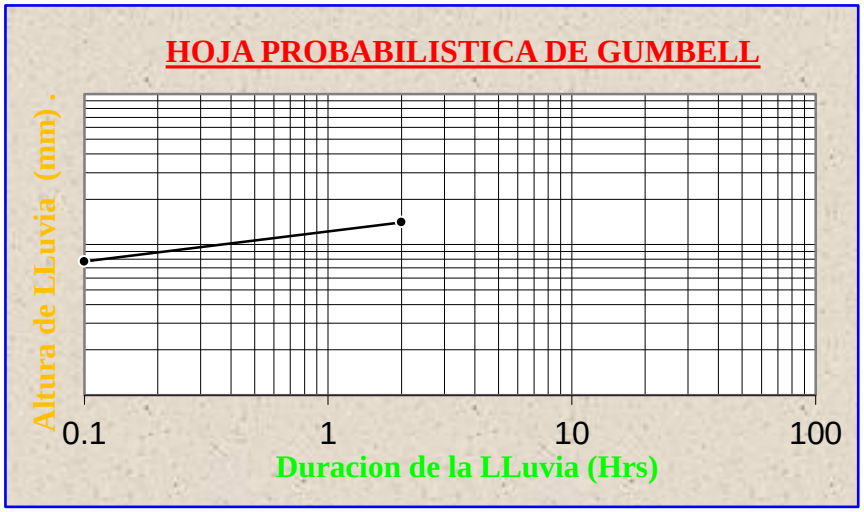
T (años) =	75
t (Hrs)	HtT (mm)
0.1	72.311
2	131.646



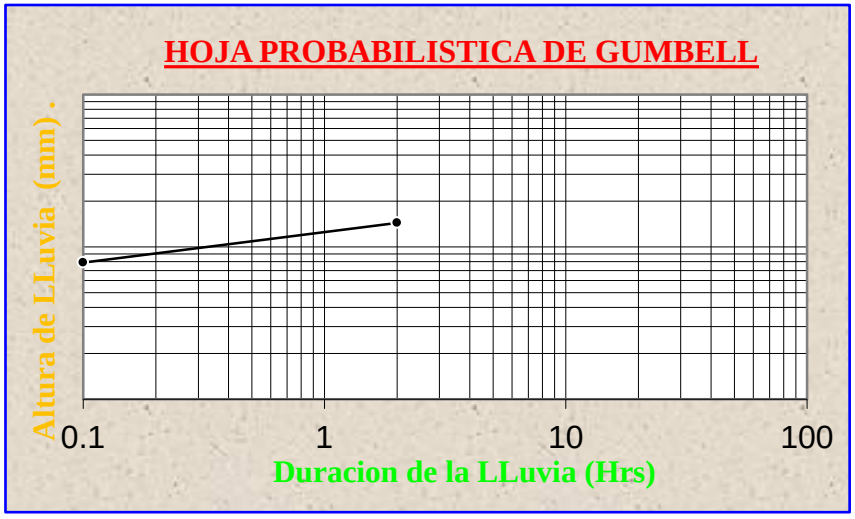
T (años) =	100
t (Hrs)	HtT (mm)
0.1	75.053
2	136.639



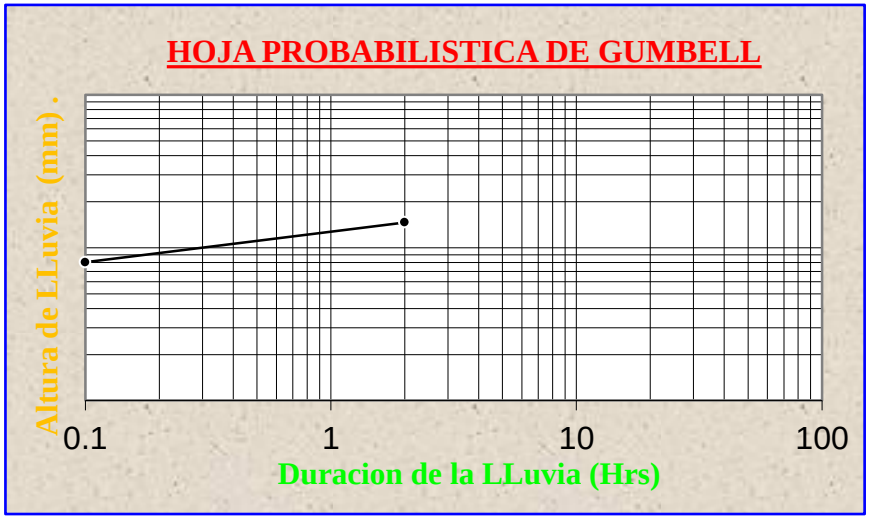
T (años) =	125
t (Hrs)	HtT (mm)
0.1	77.180
2	140.511



T (años) =	150
t (Hrs)	HtT (mm)
0.1	78.918
2	143.675



T (años) =	175
t (Hrs)	HtT (mm)
0.1	80.387
2	146.350



LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.20
Ed = 77.8138

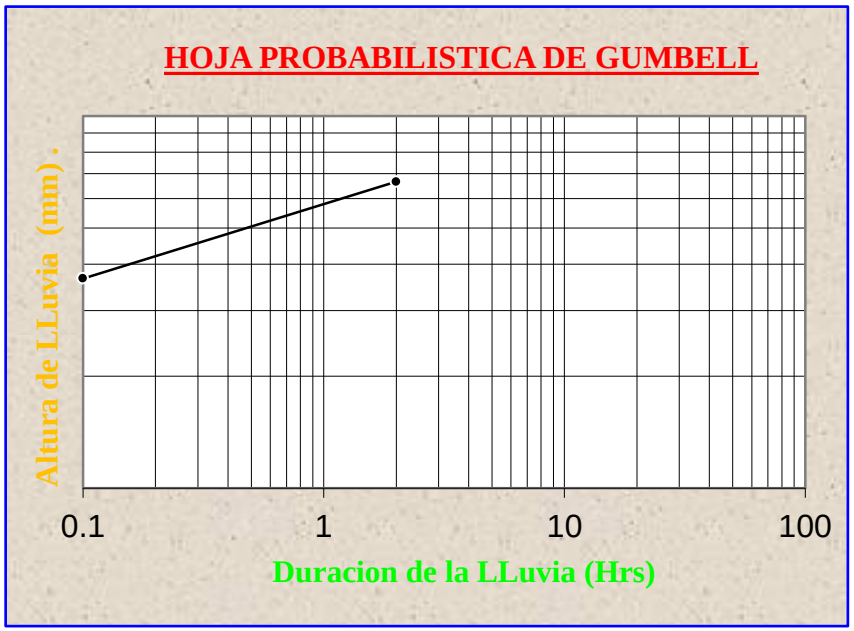
α = 12
Kd = 0.7471

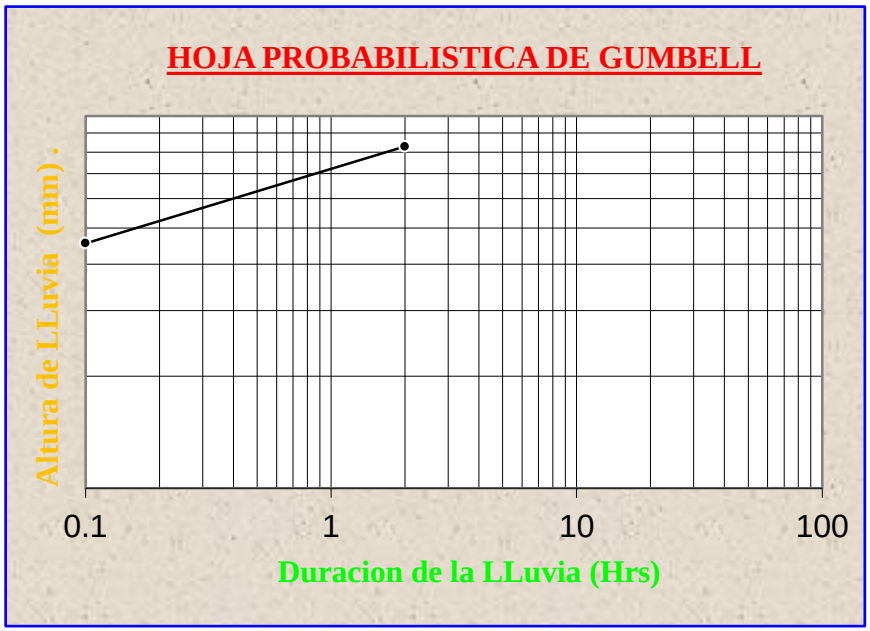
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE CARAPARI

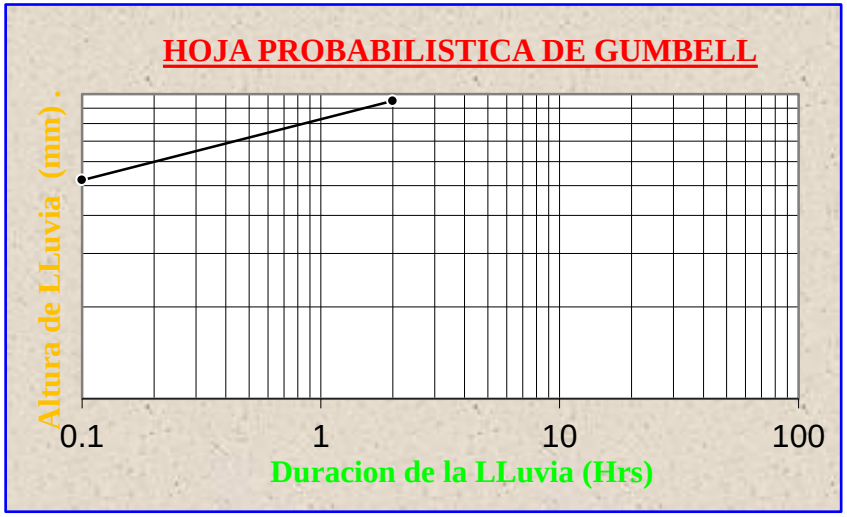
T (años) =	2
t (Hrs)	HtT (mm)
0.1	36.586
2	66.607

T (años) =	5
t (Hrs)	HtT (mm)
0.1	45.466
2	82.773

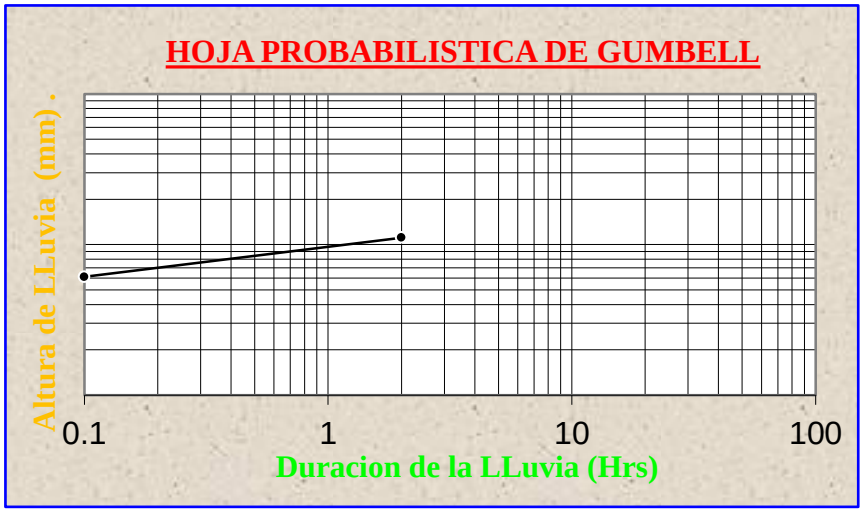




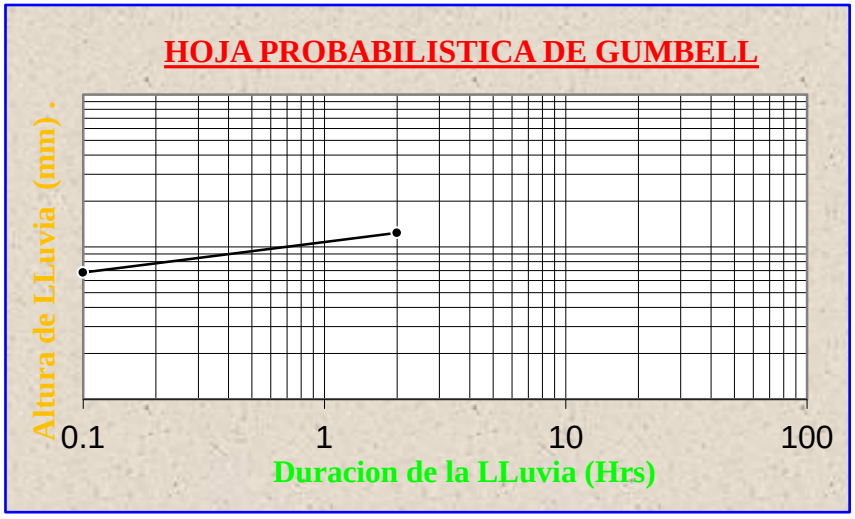
T (años) =	10
t (Hrs)	HtT (mm)
0.1	52.183
2	95.002



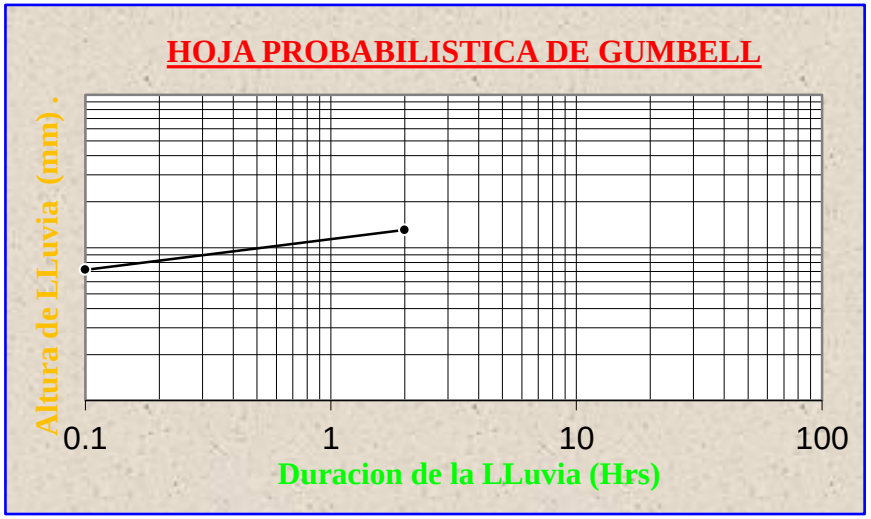
T (años) =	25
t (Hrs)	HtT (mm)
0.1	61.063
2	111.168



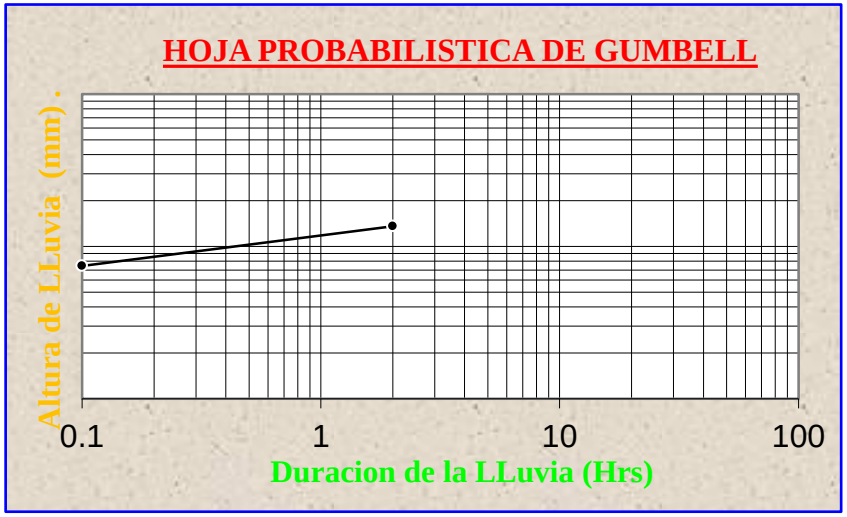
T (años) =	50
t (Hrs)	HtT (mm)
0.1	67.780
2	123.397



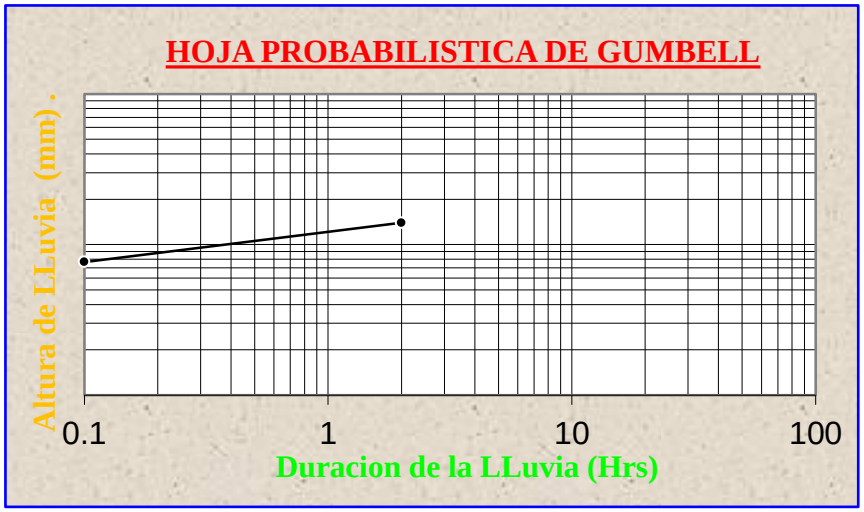
T (años) =	75
t (Hrs)	HtT (mm)
0.1	71.709
2	130.551



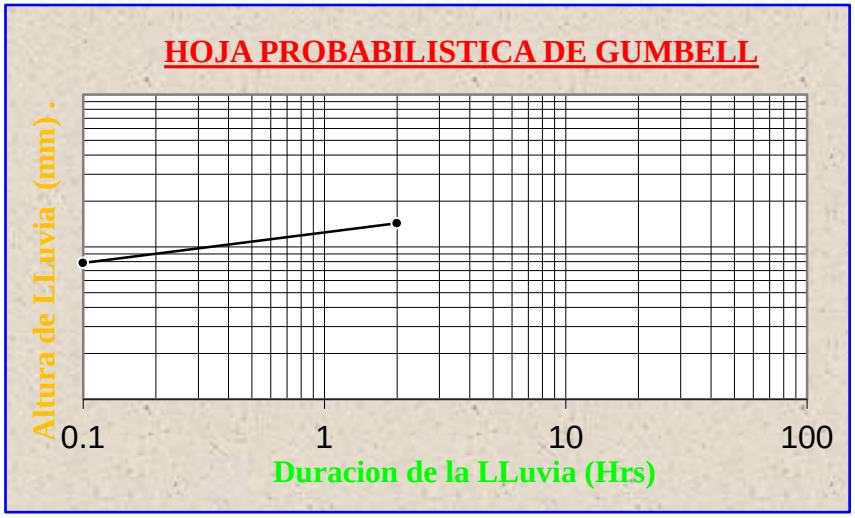
T (años) =	100
t (Hrs)	HtT (mm)
0.1	74.497
2	135.626



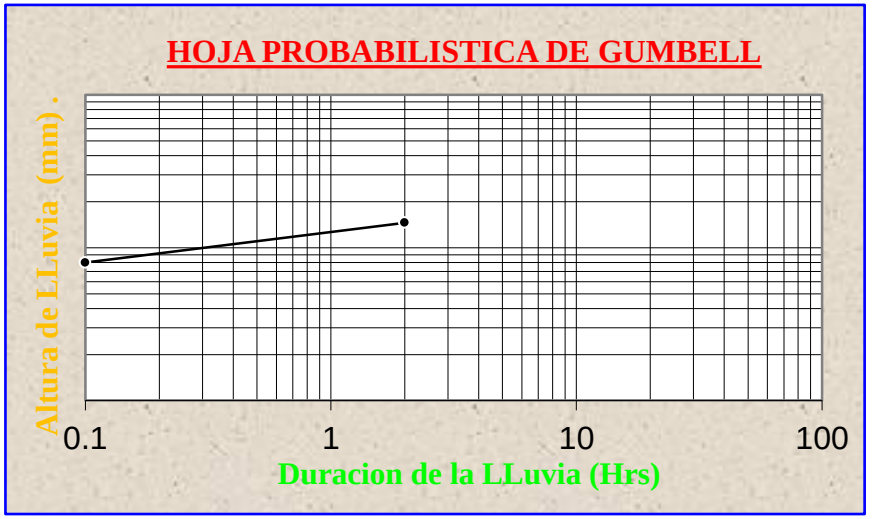
T (años) =	125
t (Hrs)	HtT (mm)
0.1	76.659
2	139.563



T (años) =	150
t (Hrs)	HtT (mm)
0.1	78.426
2	142.780



T (años) =	175
t (Hrs)	HtT (mm)
0.1	79.920
2	145.500



LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.20
Ed = 24.6862

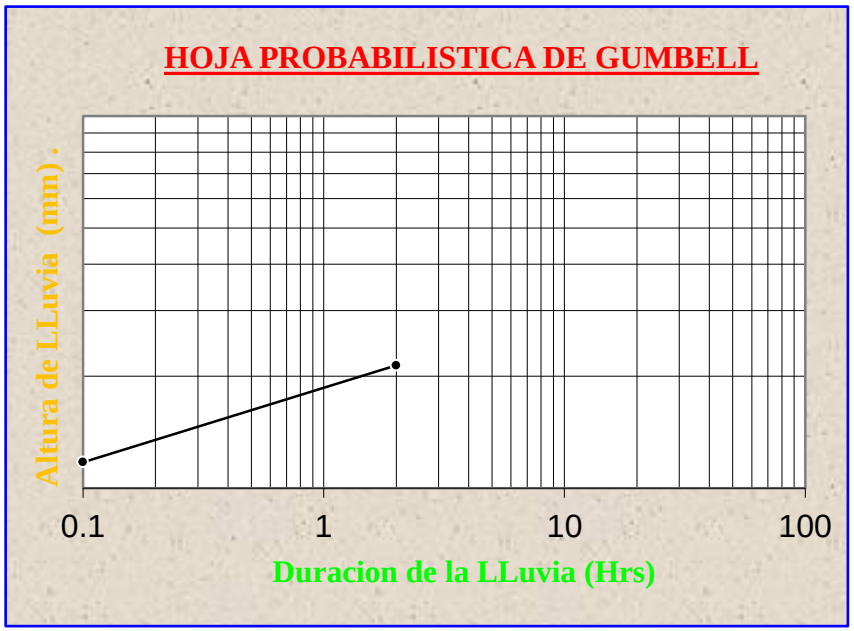
α = 12
Kd = 0.79410

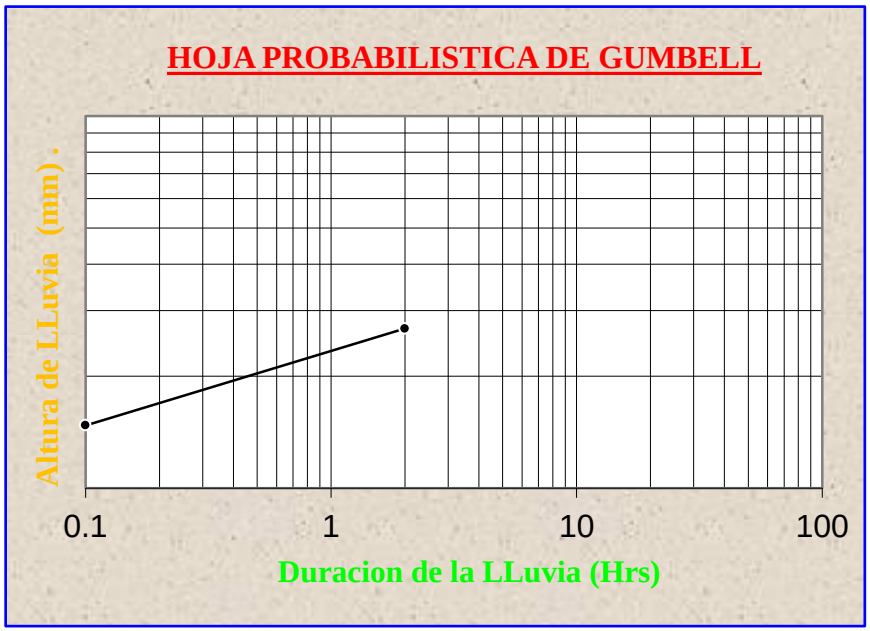
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE EL PUENTE

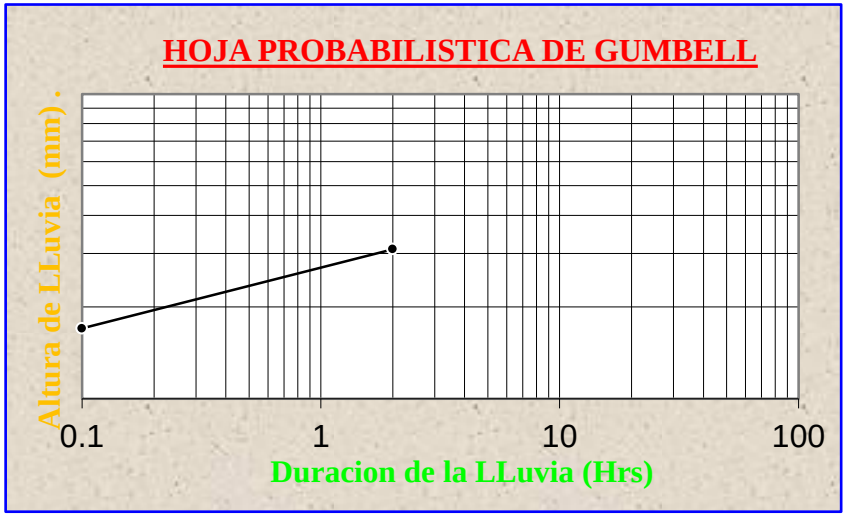
T (años) =	2
t (Hrs)	HtT (mm)
0.1	11.741
2	21.375

T (años) =	5
t (Hrs)	HtT (mm)
0.1	14.735
2	26.827

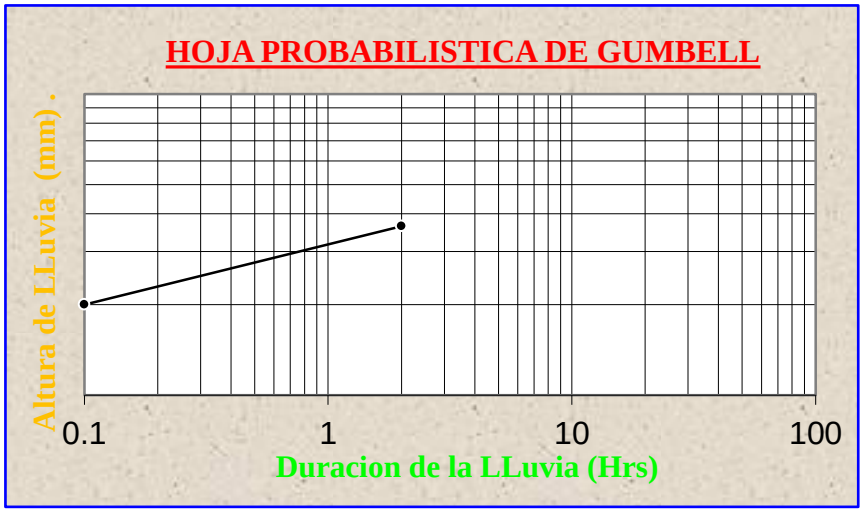




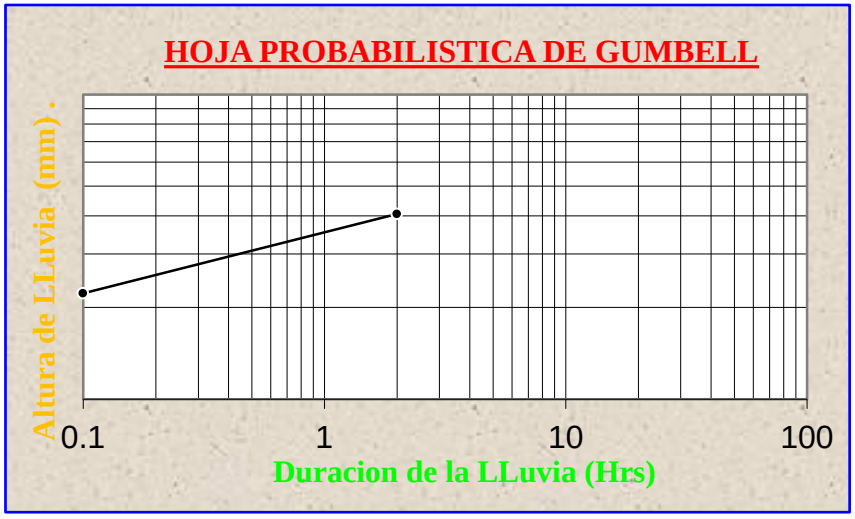
T (años) =	10
t (Hrs)	HtT (mm)
0.1	17.001
2	30.951



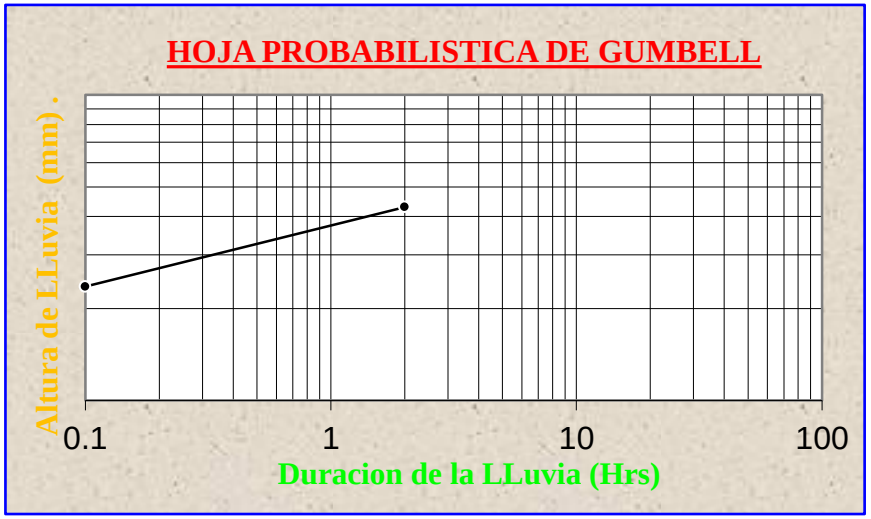
T (años) =	25
t (Hrs)	HtT (mm)
0.1	19.995
2	36.402



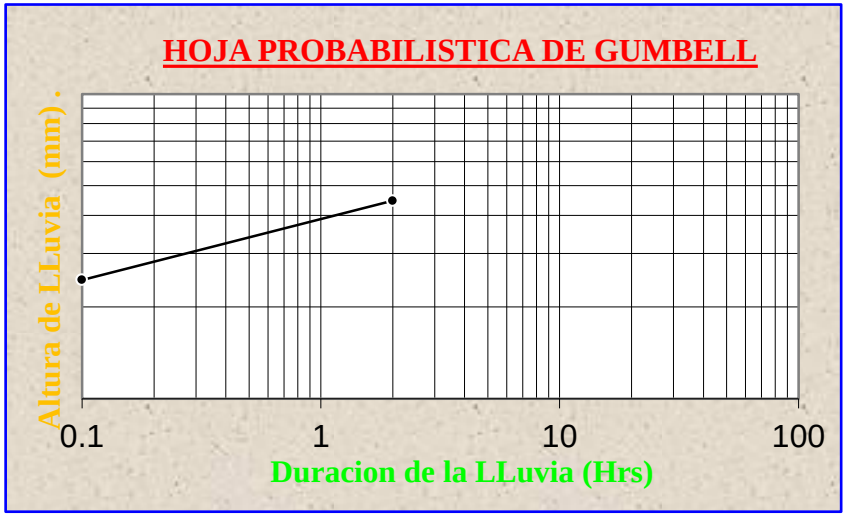
T (años) =	50
t (Hrs)	HtT (mm)
0.1	22.260
2	40.526



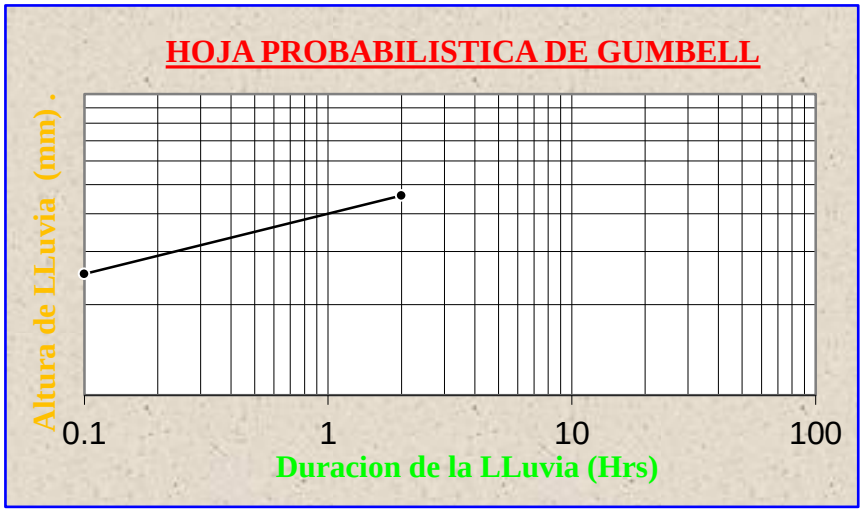
T (años) =	75
t (Hrs)	HtT (mm)
0.1	23.585
2	42.938



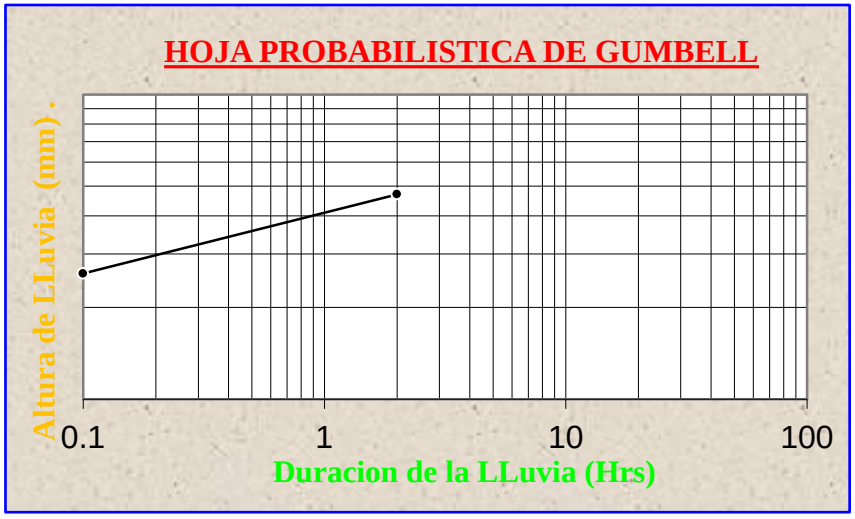
T (años) =	100
t (Hrs)	HtT (mm)
0.1	24.525
2	44.650



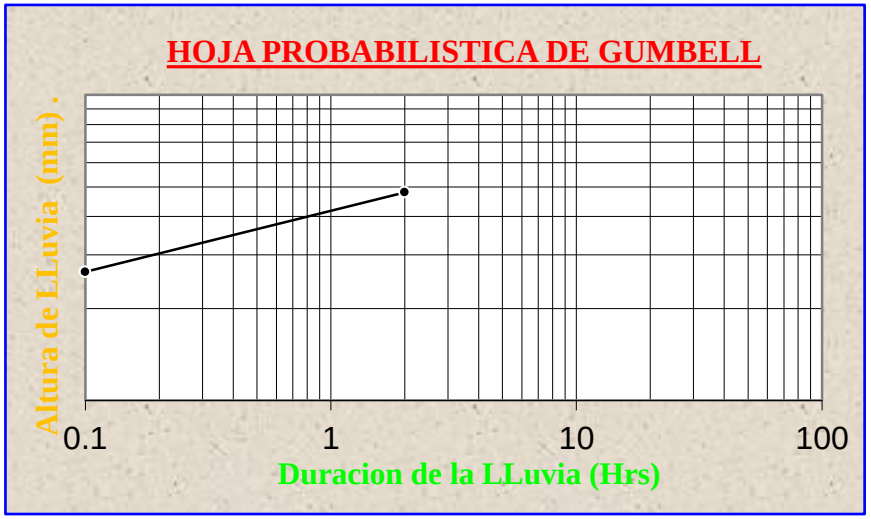
T (años) =	125
t (Hrs)	HtT (mm)
0.1	25.255
2	45.978



T (años) =	150
t (Hrs)	HtT (mm)
0.1	25.850
2	47.062



T (años) =	175
t (Hrs)	HtT (mm)
0.1	26.354
2	47.979



LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.20
Ed = 68.6153

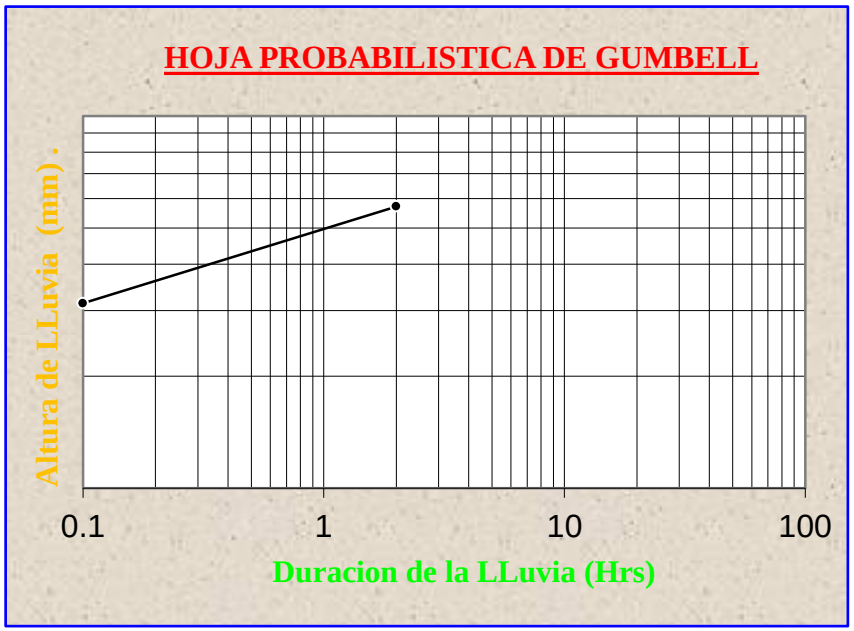
α = 12
Kd = 0.6349

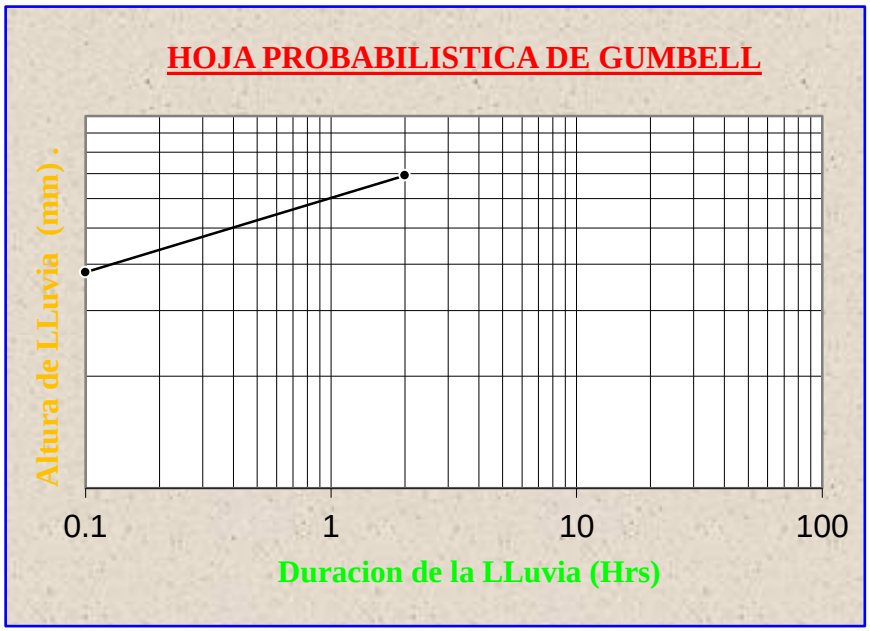
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE ENTRE RIOS

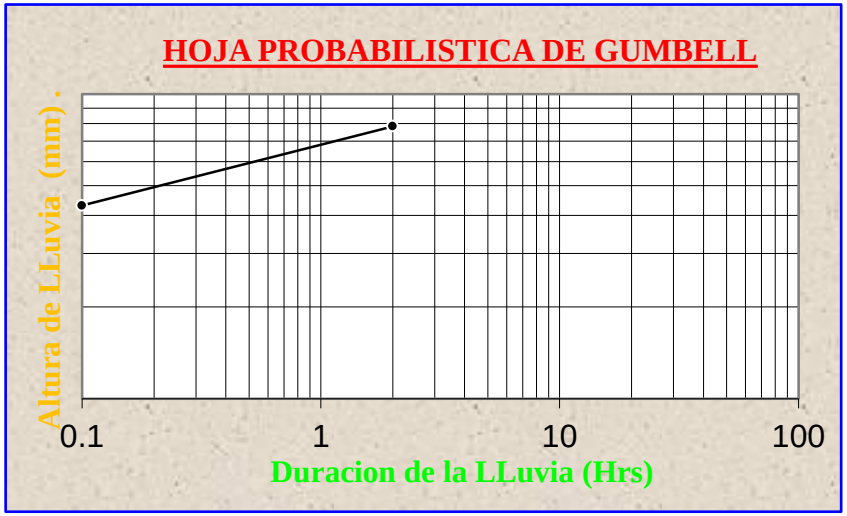
T (años) =	2
t (Hrs)	HtT (mm)
0.1	31.372
2	57.115

T (años) =	5
t (Hrs)	HtT (mm)
0.1	38.027
2	69.231

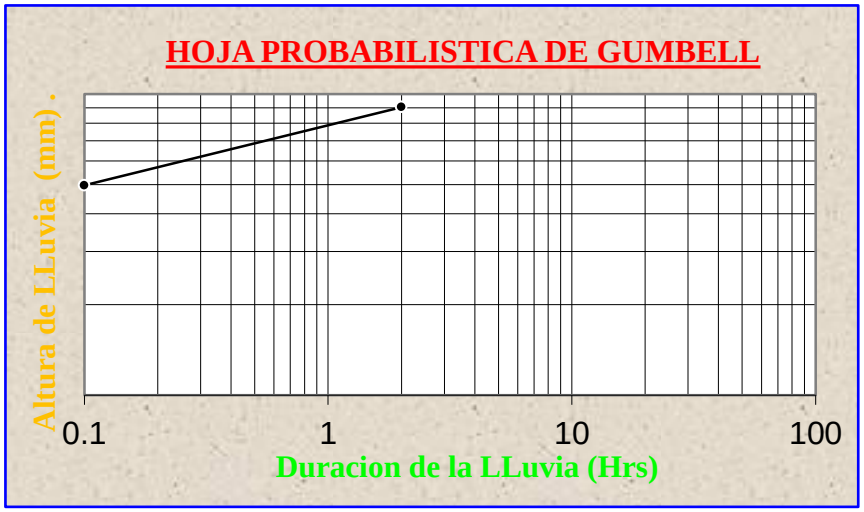




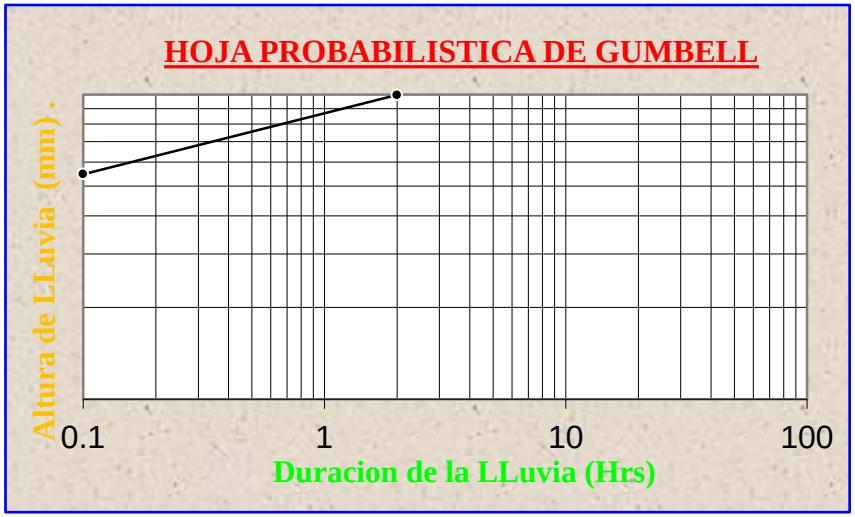
T (años) =	10
t (Hrs)	HtT (mm)
0.1	43.061
2	78.396



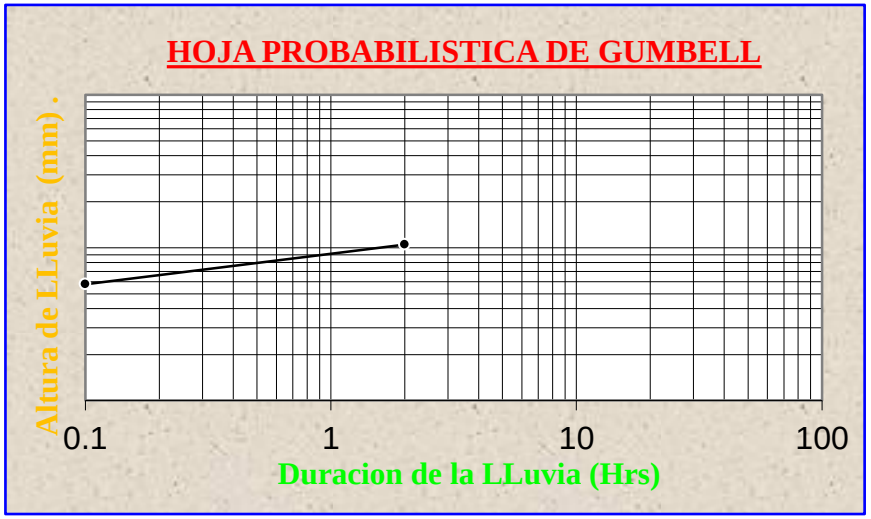
T (años) =	25
t (Hrs)	HtT (mm)
0.1	49.716
2	90.512



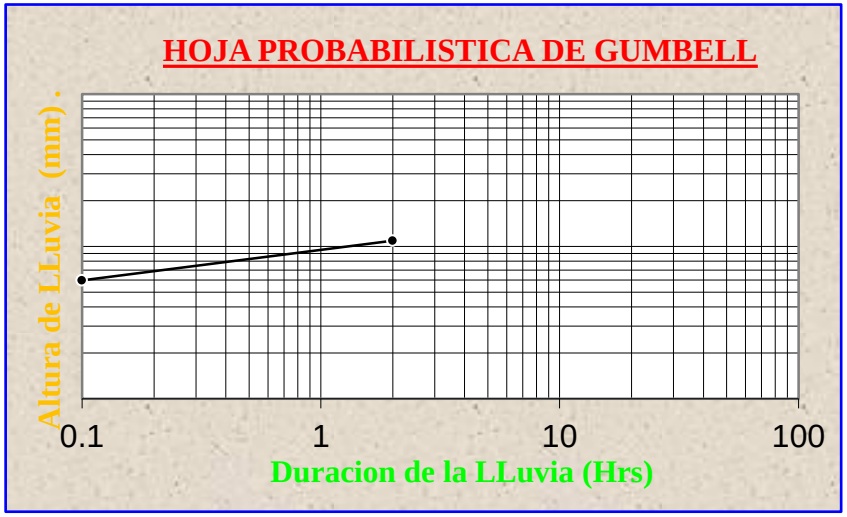
T (años) =	50
t (Hrs)	HtT (mm)
0.1	54.750
2	99.677



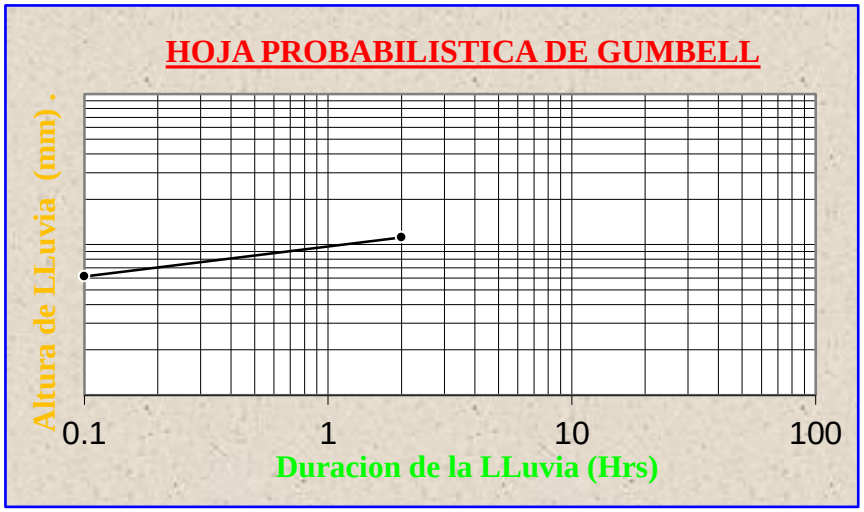
T (años) =	75
t (Hrs)	HtT (mm)
0.1	57.695
2	105.038



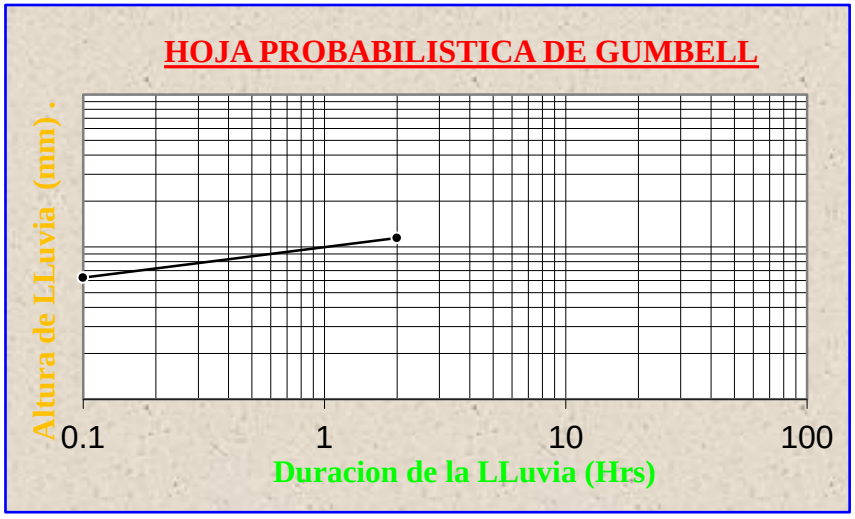
T (años) =	100
t (Hrs)	HtT (mm)
0.1	59.785
2	108.842



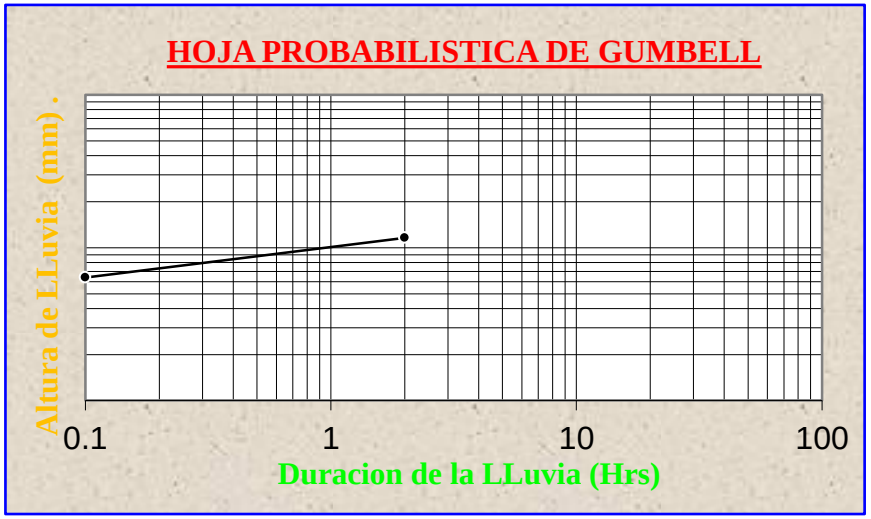
T (años) =	125
t (Hrs)	HtT (mm)
0.1	61.405
2	111.792



T (años) =	150
t (Hrs)	HtT (mm)
0.1	62.729
2	114.203



T (años) =	175
t (Hrs)	HtT (mm)
0.1	63.849
2	116.241



LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.20
Ed = 33.9056

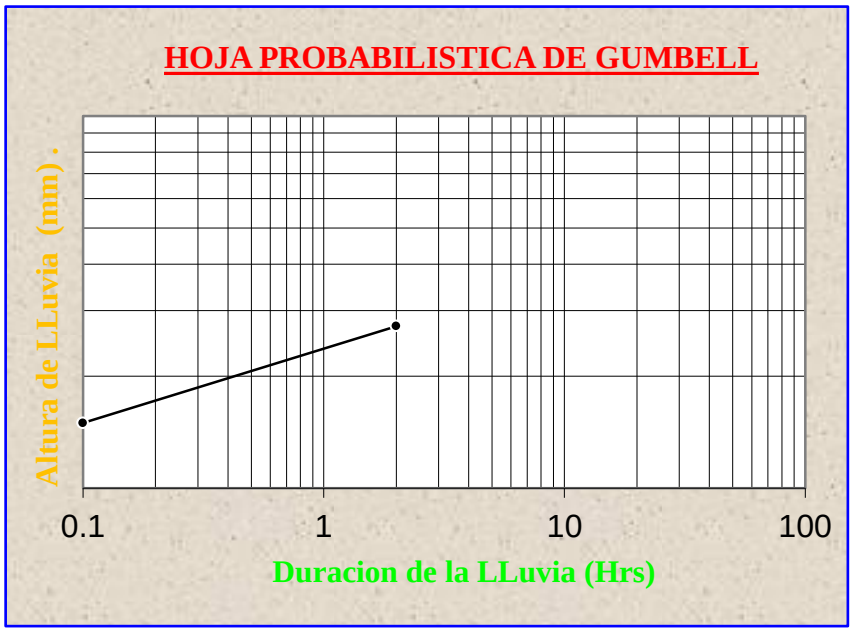
α = 12
Kd = 0.4959

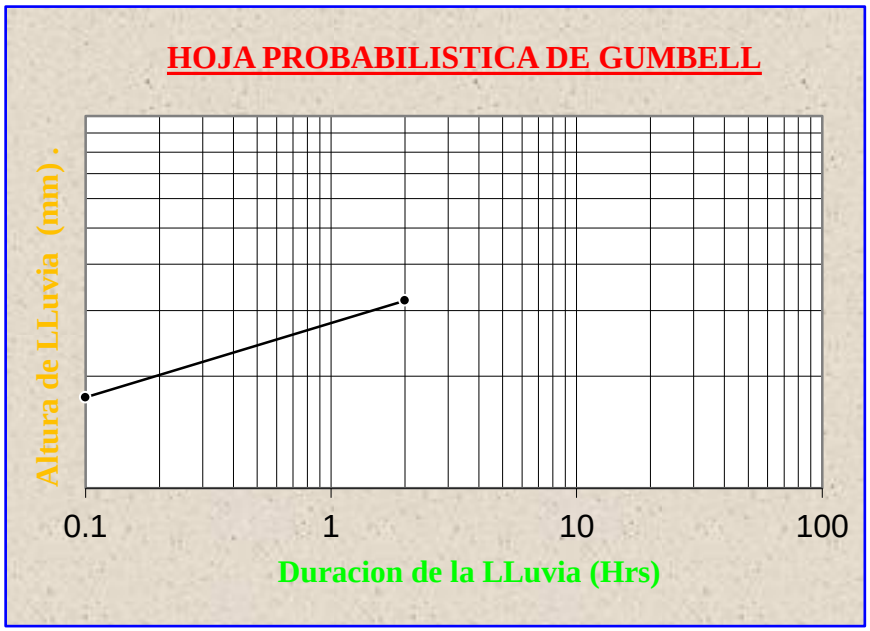
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE ISCAYACHI

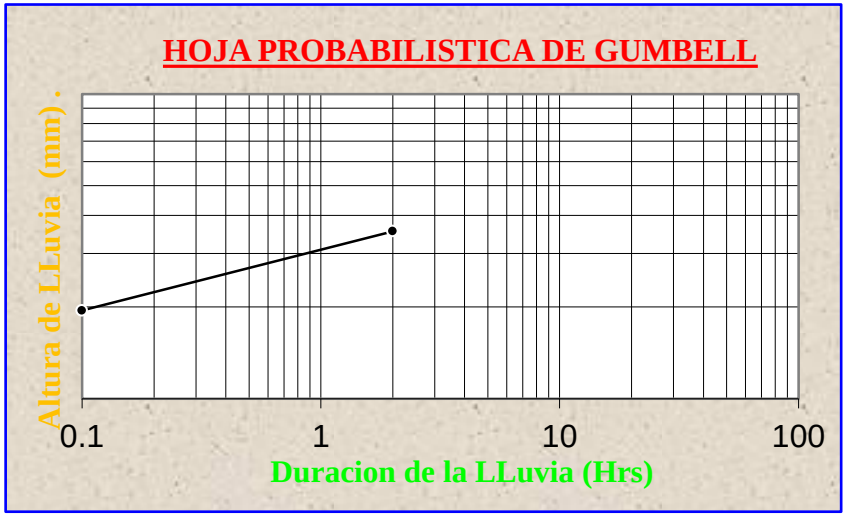
T (años) =	2
t (Hrs)	HtT (mm)
0.1	14.957
2	27.231

T (años) =	5
t (Hrs)	HtT (mm)
0.1	17.525
2	31.906

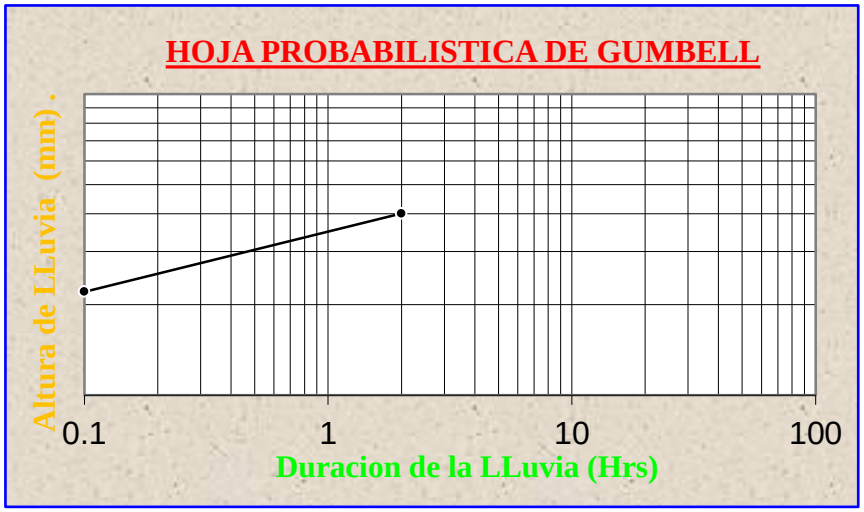




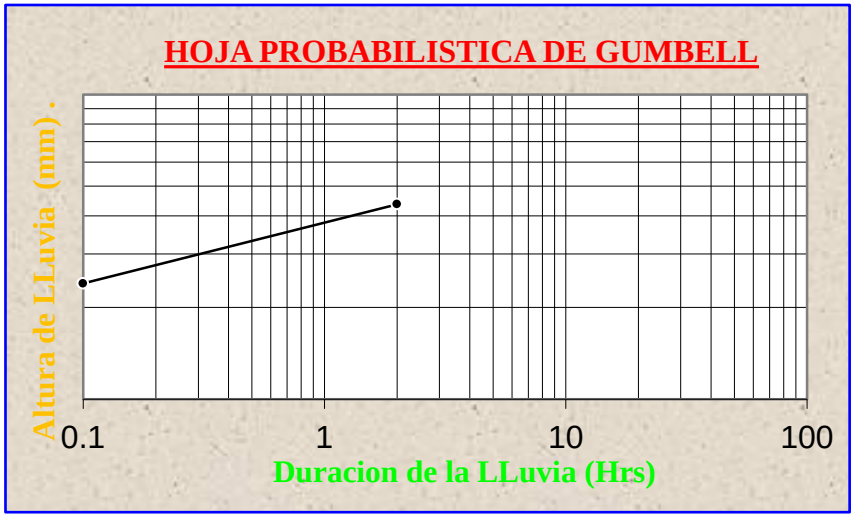
T (años) =	10
t (Hrs)	HtT (mm)
0.1	19.468
2	35.443



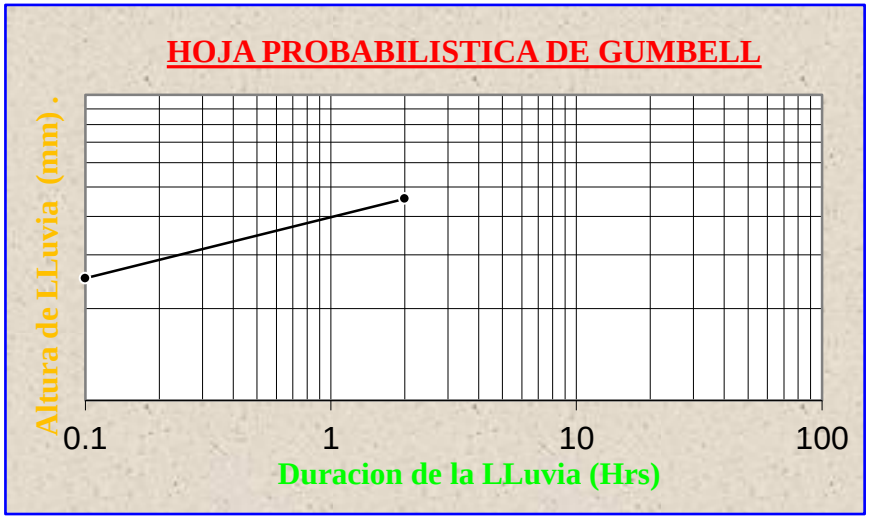
T (años) =	25
t (Hrs)	HtT (mm)
0.1	22.036
2	40.118



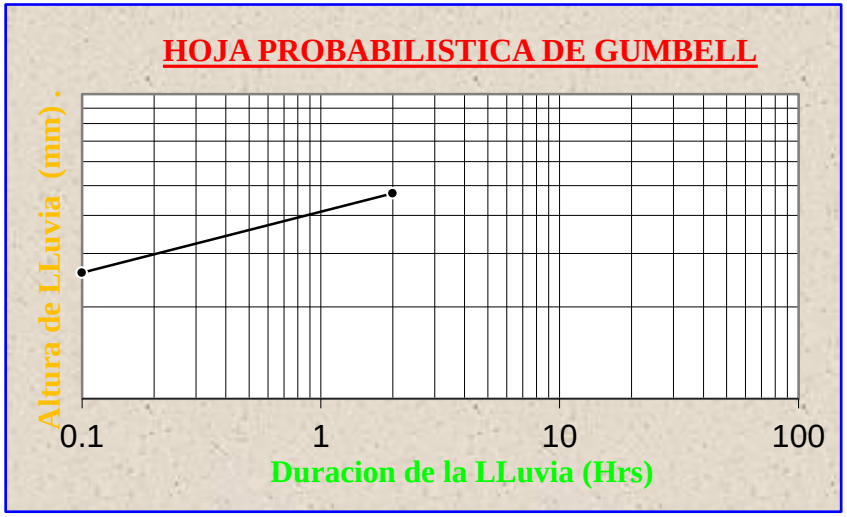
T (años) =	50
t (Hrs)	HtT (mm)
0.1	23.979
2	43.655



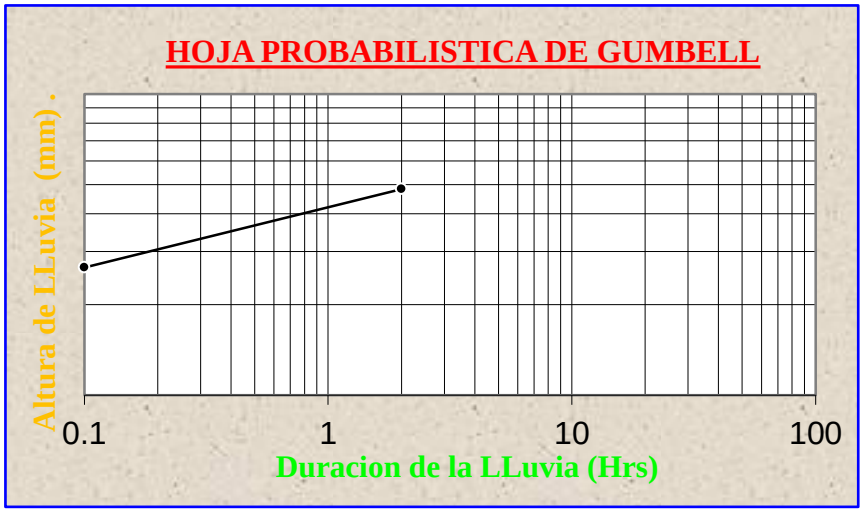
T (años) =	75
t (Hrs)	HtT (mm)
0.1	25.115
2	45.724



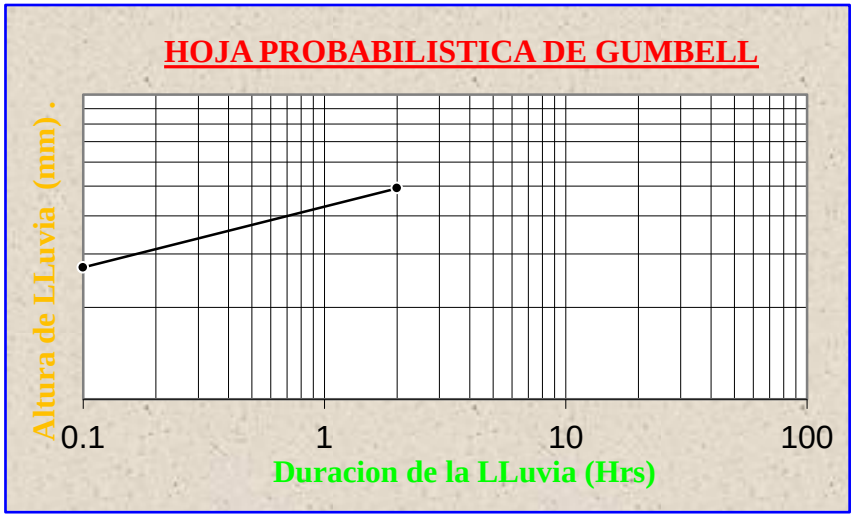
T (años) =	100
t (Hrs)	HtT (mm)
0.1	25.921
2	47.192



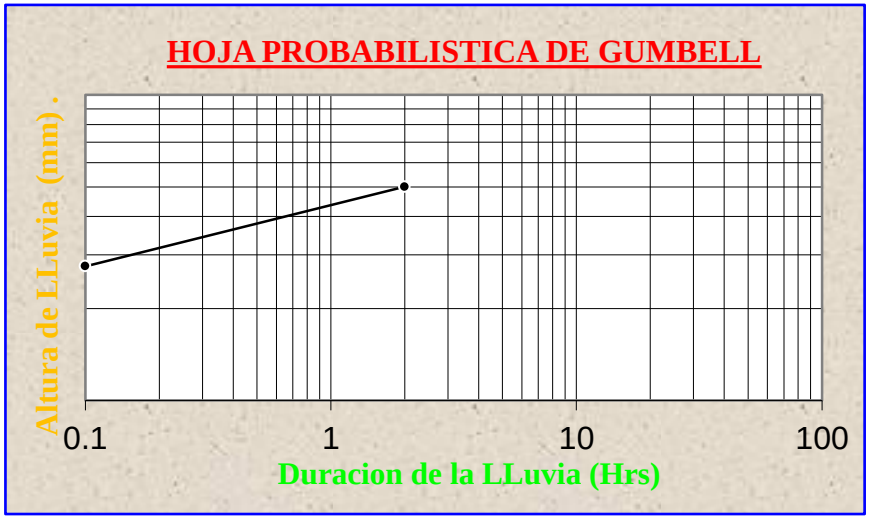
T (años) =	125
t (Hrs)	HtT (mm)
0.1	26.547
2	48.330



T (años) =	150
t (Hrs)	HtT (mm)
0.1	27.058
2	49.261



T (años) =	175
t (Hrs)	HtT (mm)
0.1	27.490
2	50.047



LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.20
Ed = 41.0061

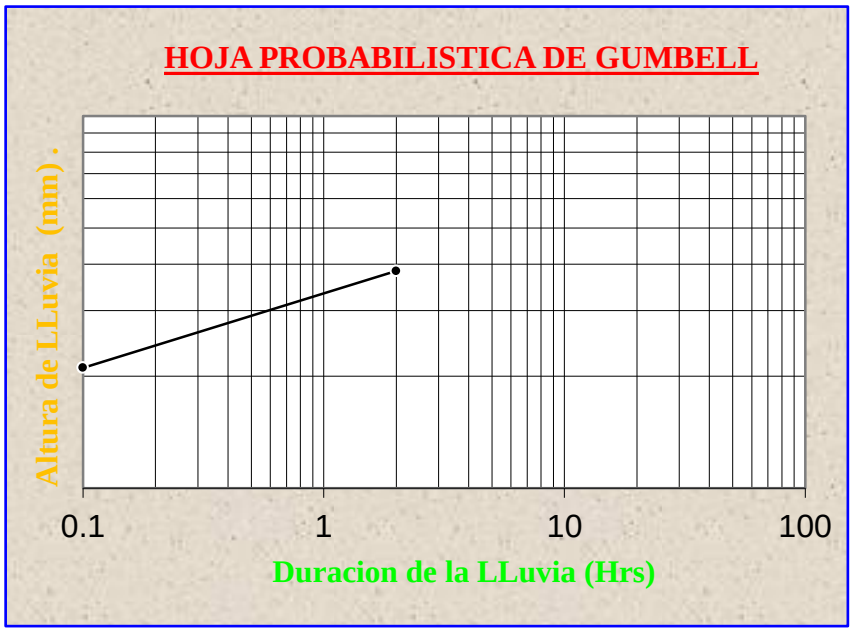
α = 12
Kd = 1.1192

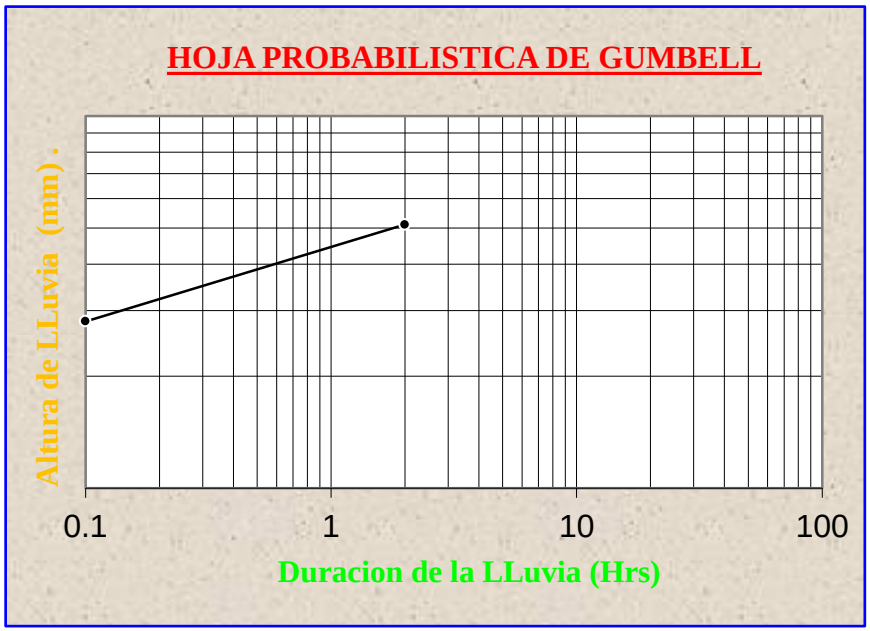
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE PADCAYA

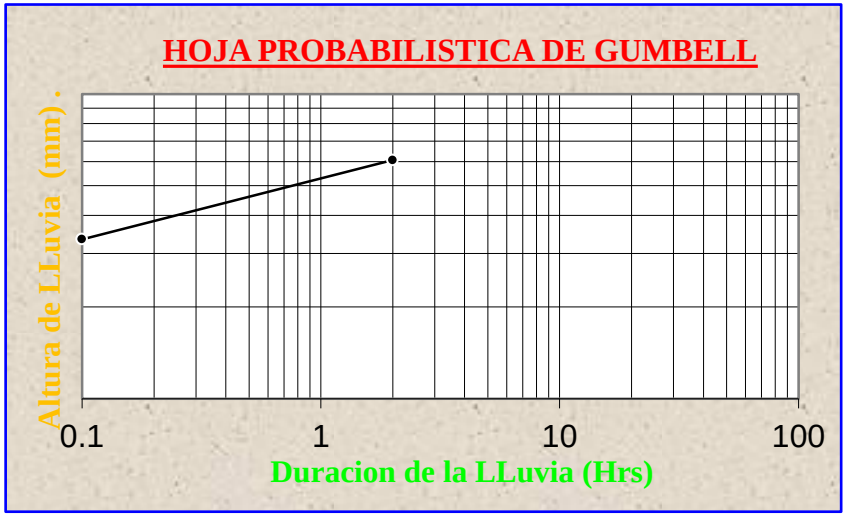
T (años) =	2
t (Hrs)	HtT (mm)
0.1	21.043
2	38.311

T (años) =	5
t (Hrs)	HtT (mm)
0.1	28.053
2	51.073

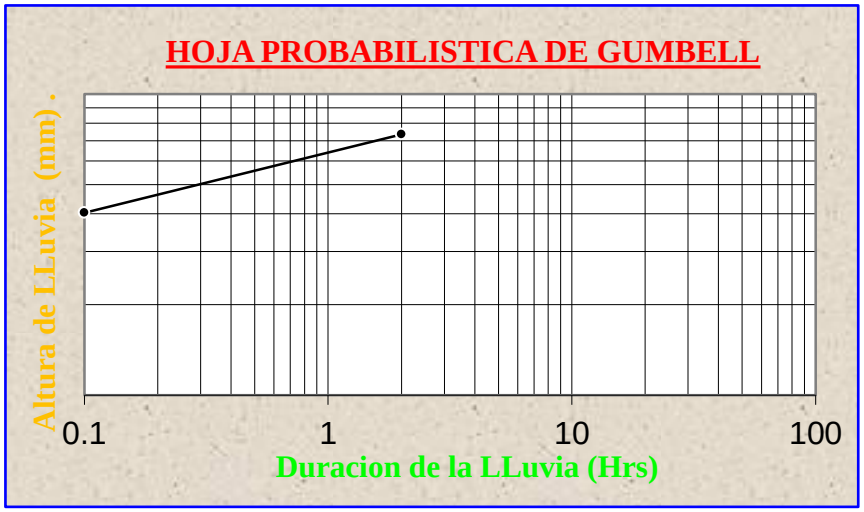




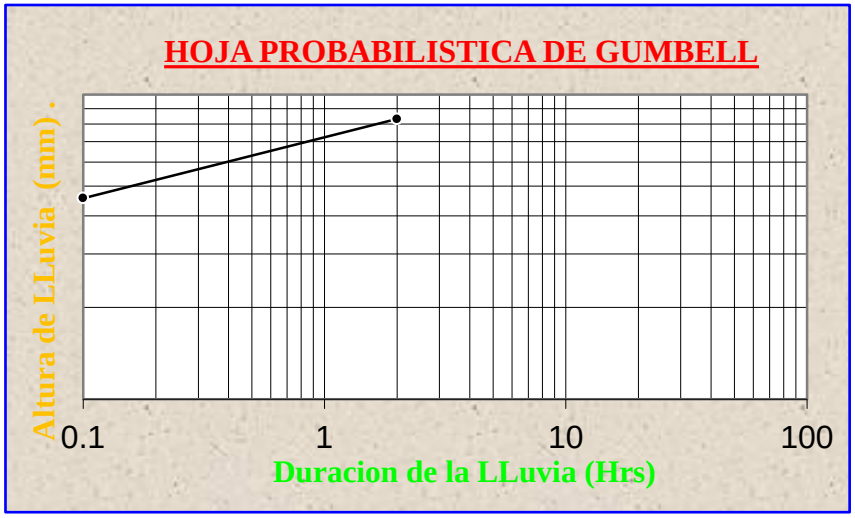
T (años) =	10
t (Hrs)	HtT (mm)
0.1	33.356
2	60.727



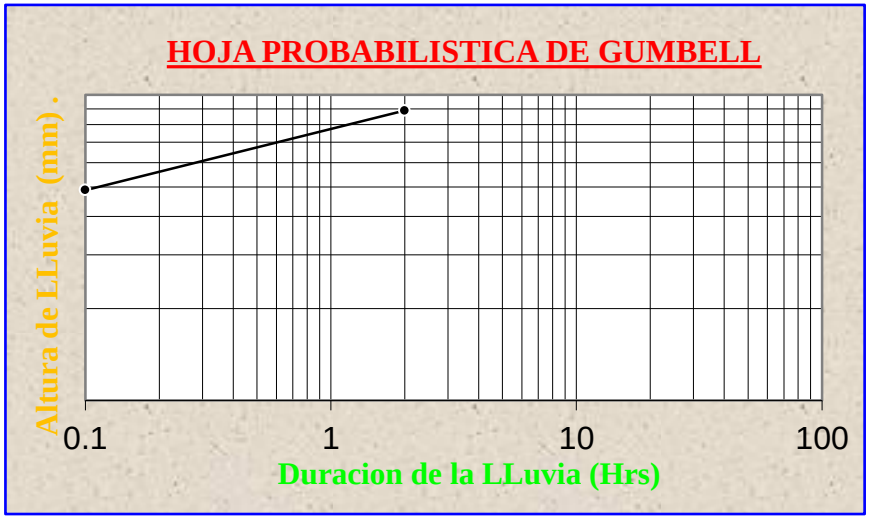
T (años) =	25
t (Hrs)	HtT (mm)
0.1	40.367
2	73.490



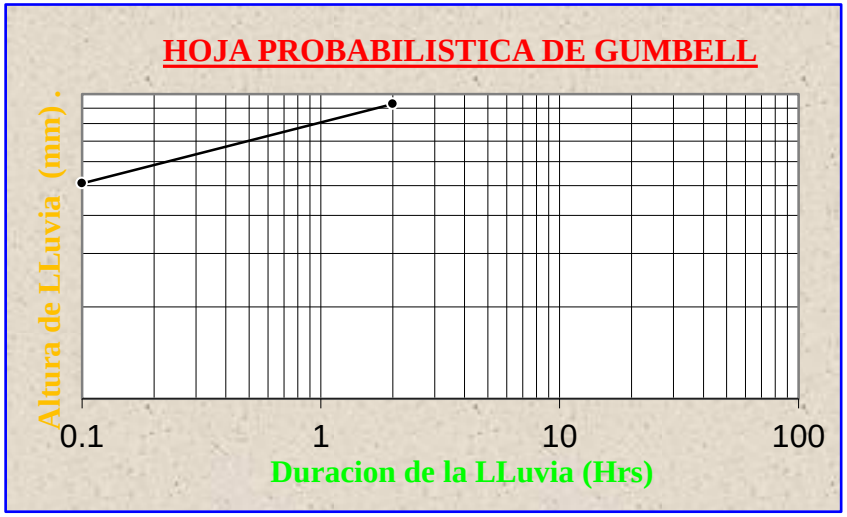
T (años) =	50
t (Hrs)	HtT (mm)
0.1	45.670
2	83.144



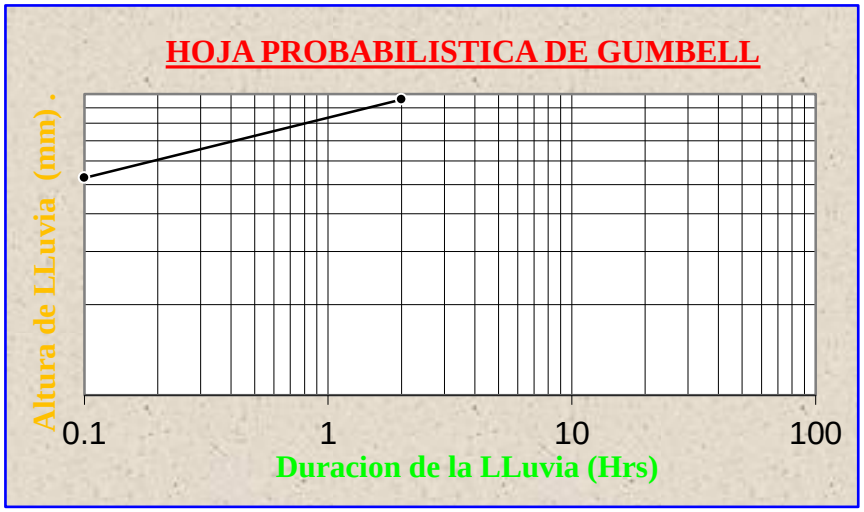
T (años) =	75
t (Hrs)	HtT (mm)
0.1	48.772
2	88.792



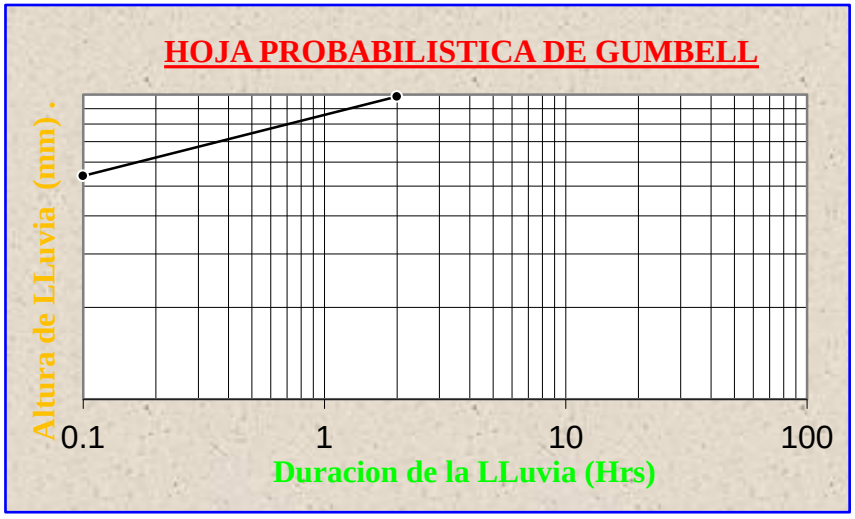
T (años) =	100
t (Hrs)	HtT (mm)
0.1	50.973
2	92.799



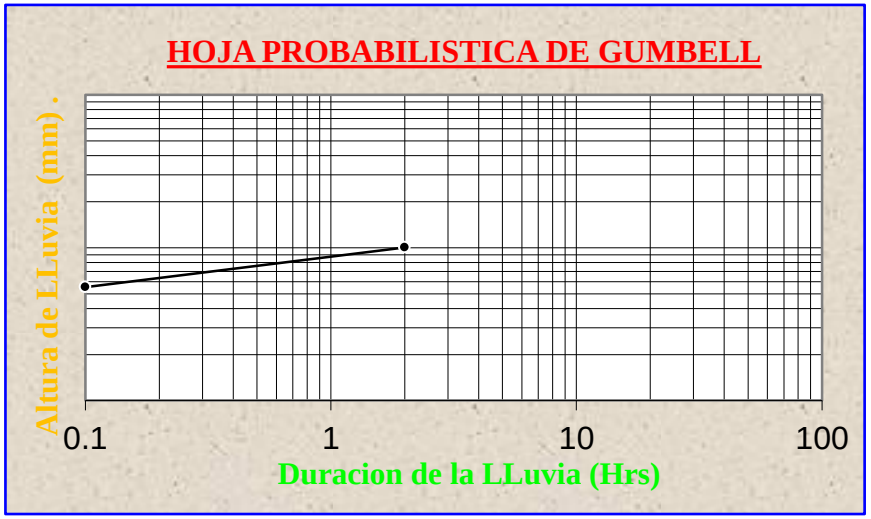
T (años) =	125
t (Hrs)	HtT (mm)
0.1	52.680
2	95.907



T (años) =	150
t (Hrs)	HtT (mm)
0.1	54.075
2	98.446



T (años) =	175
t (Hrs)	HtT (mm)
0.1	55.254
2	100.593



LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.20
Ed = 45.0415

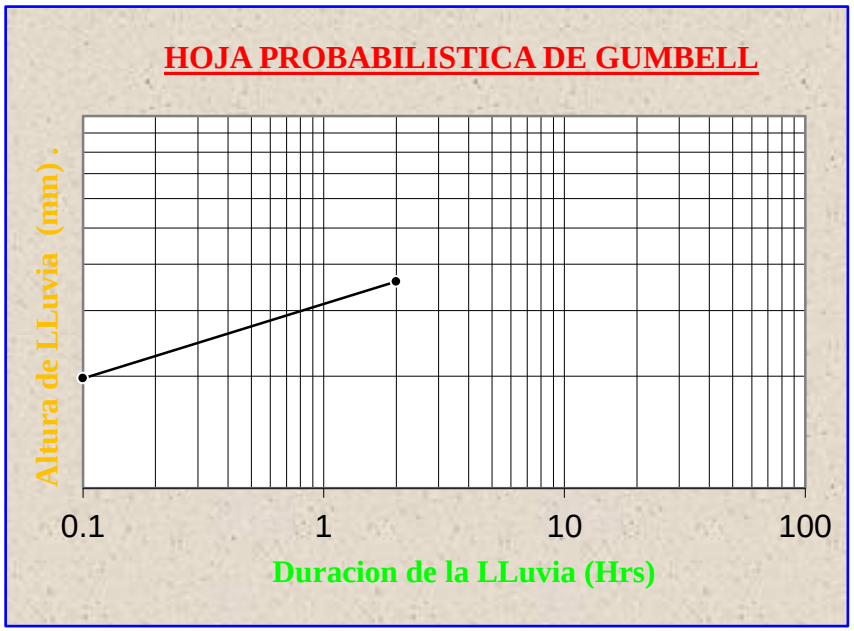
α = 12
Kd = 0.4666

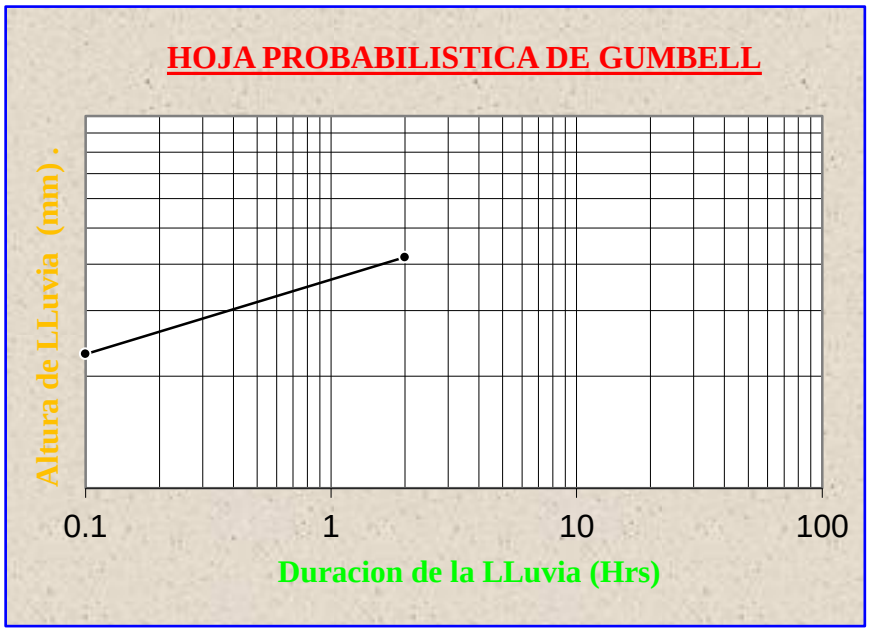
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE SAN LORENZO

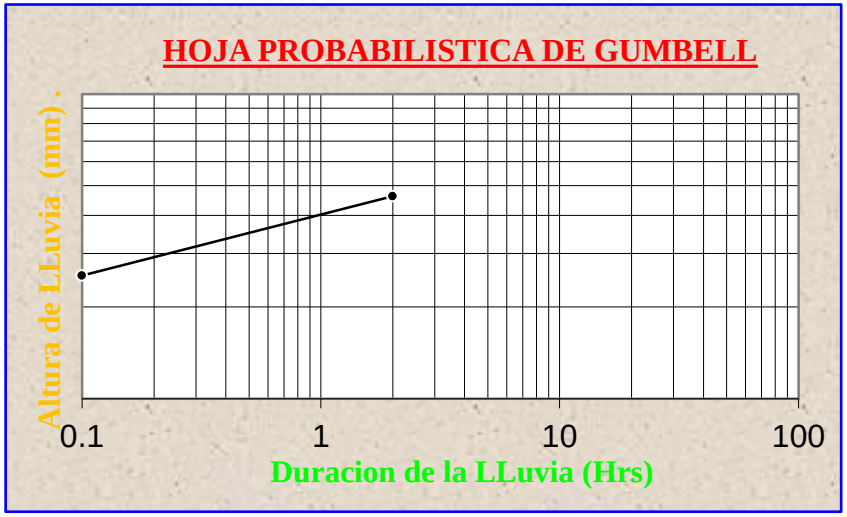
T (años) =	2
t (Hrs)	HtT (mm)
0.1	19.718
2	35.898

T (años) =	5
t (Hrs)	HtT (mm)
0.1	22.928
2	41.743

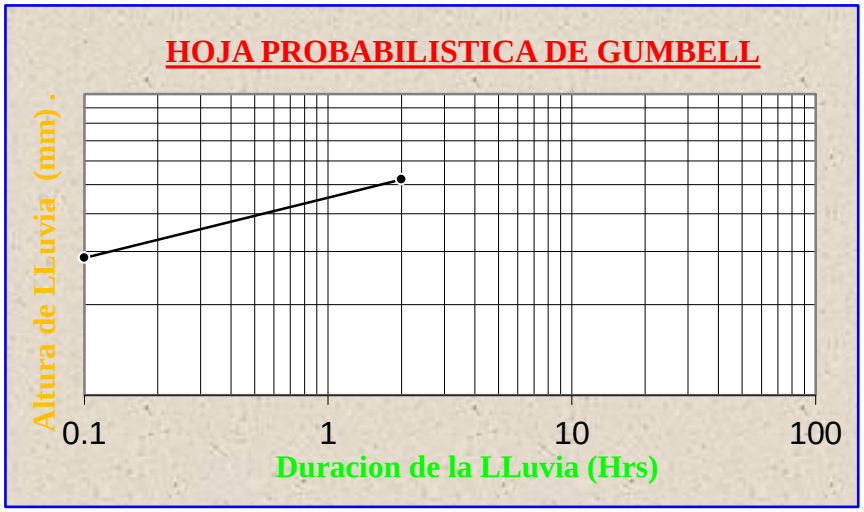




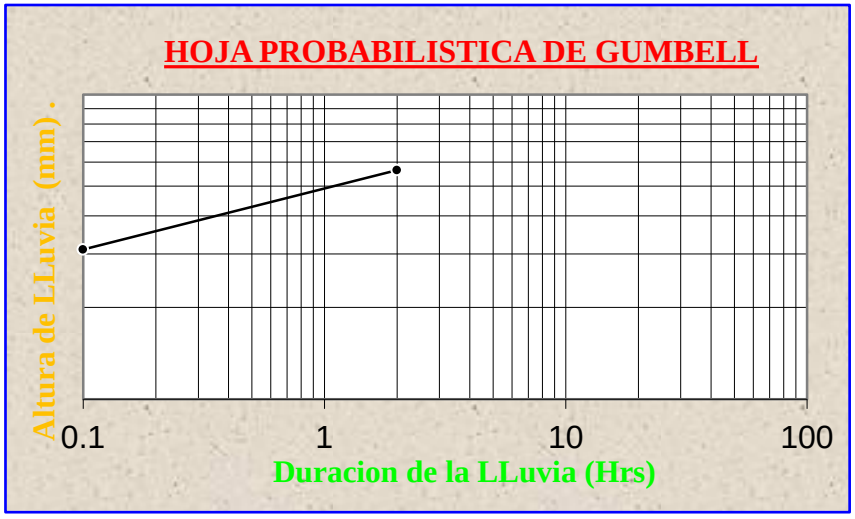
T (años) =	10
t (Hrs)	HtT (mm)
0.1	25.357
2	46.164



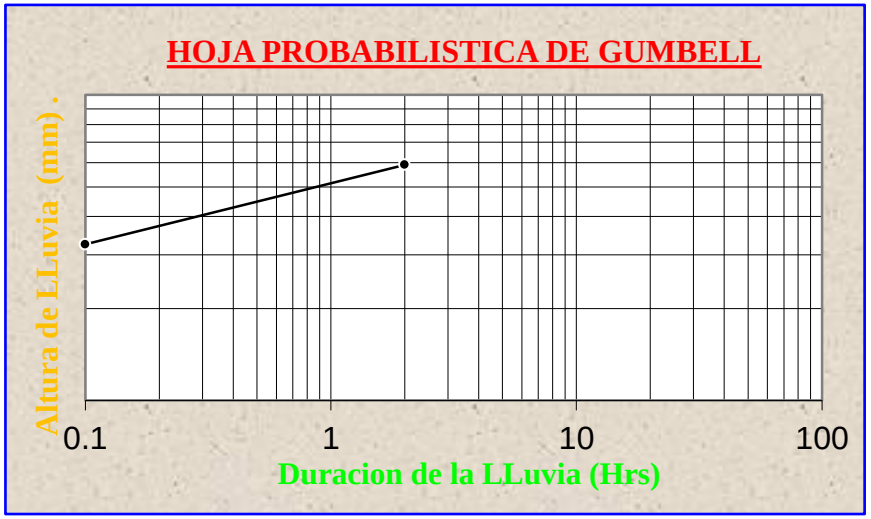
T (años) =	25
t (Hrs)	HtT (mm)
0.1	28.568
2	52.009



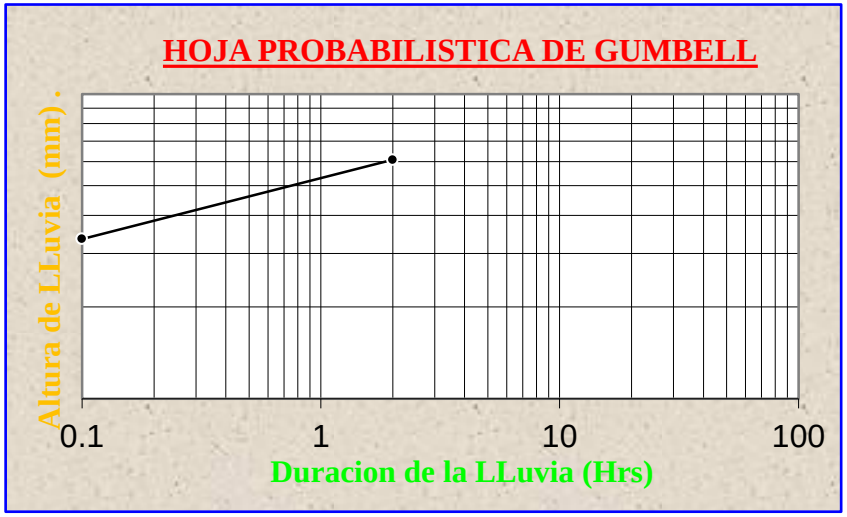
T (años) =	50
t (Hrs)	HtT (mm)
0.1	30.996
2	56.431



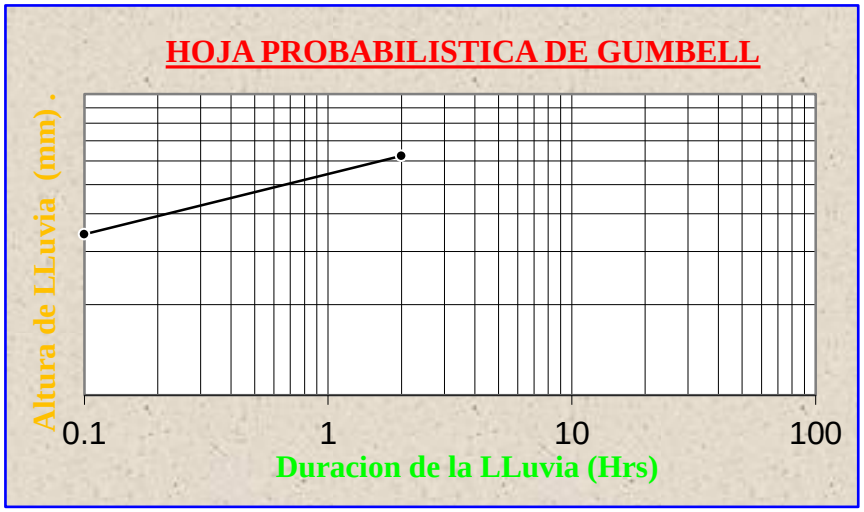
T (años) =	75
t (Hrs)	HtT (mm)
0.1	32.417
2	59.017



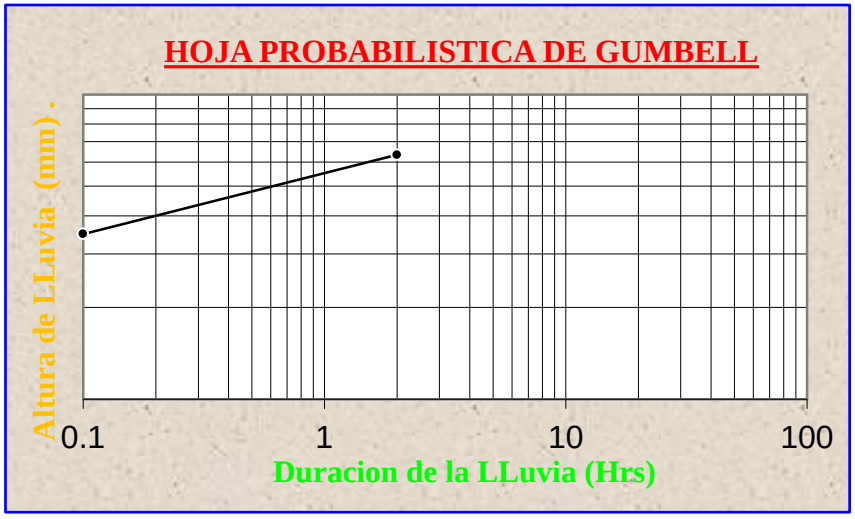
T (años) =	100
t (Hrs)	HtT (mm)
0.1	33.425
2	60.852



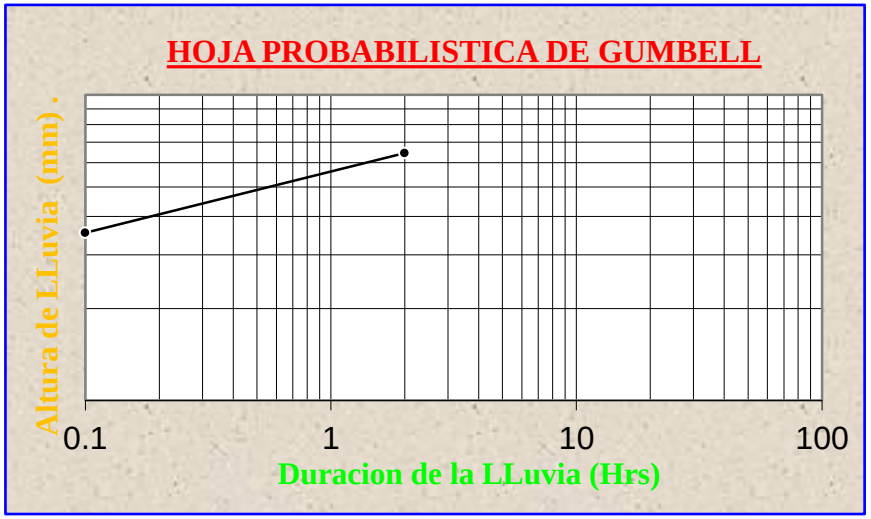
T (años) =	125
t (Hrs)	HtT (mm)
0.1	34.207
2	62.276



T (años) =	150
t (Hrs)	HtT (mm)
0.1	34.846
2	63.439



T (años) =	175
t (Hrs)	HtT (mm)
0.1	35.386
2	64.422



LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.2
Ed = 48.3138

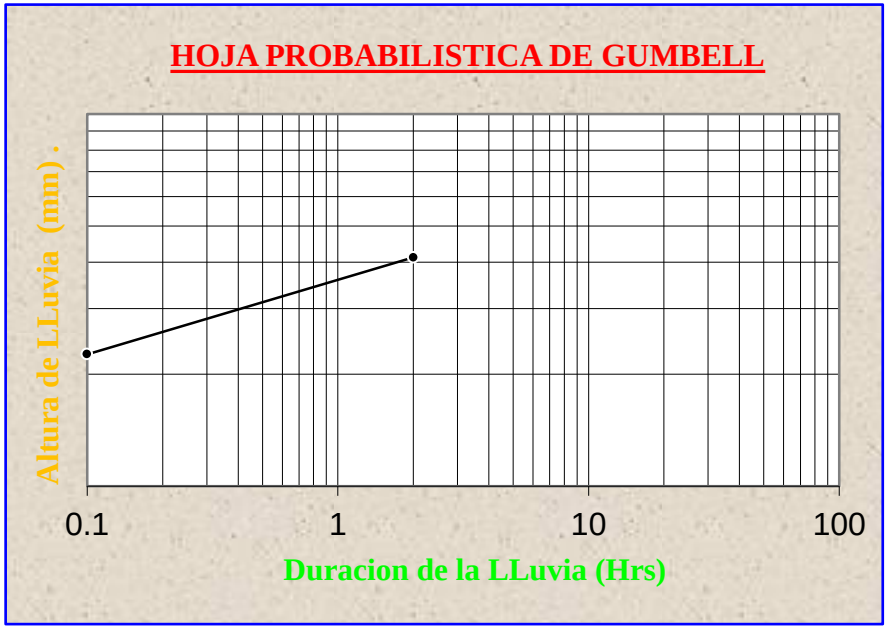
α = 12
Kd = 0.72875

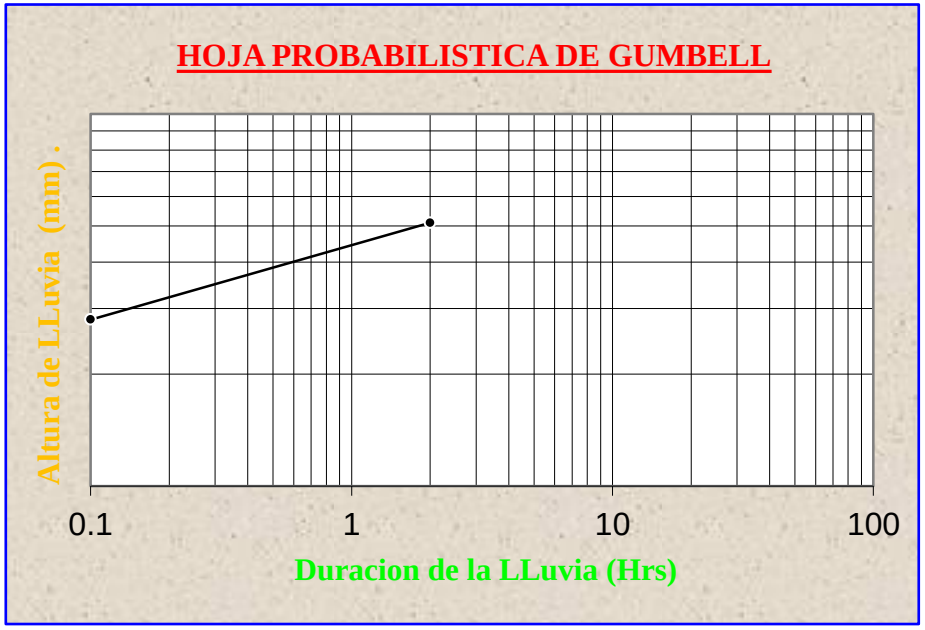
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE TARIJA

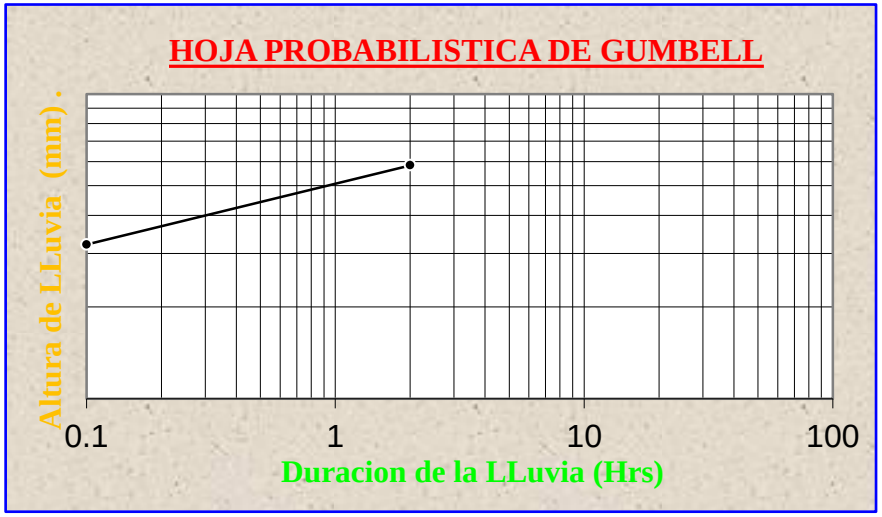
T (años) =	2
t (Hrs)	HtT (mm)
0.1	22.614
2	41.170

T (años) =	5
t (Hrs)	HtT (mm)
0.1	27.992
2	50.961

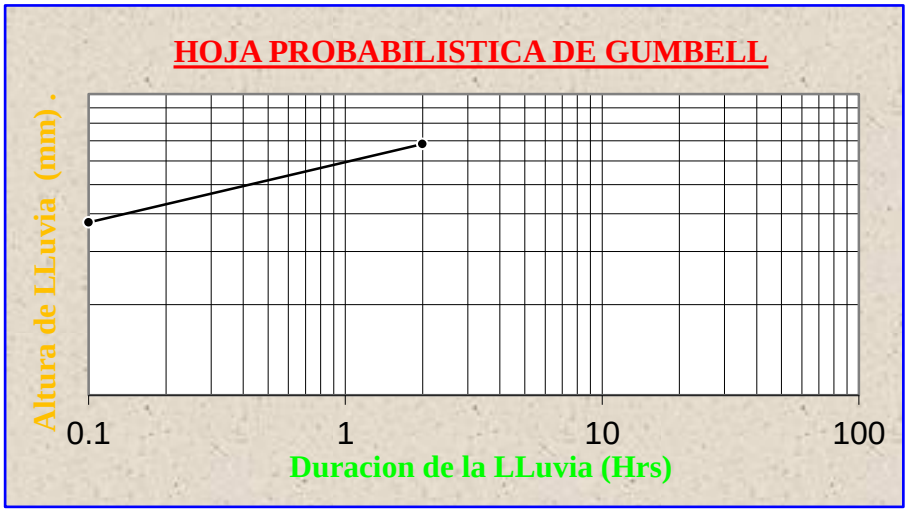




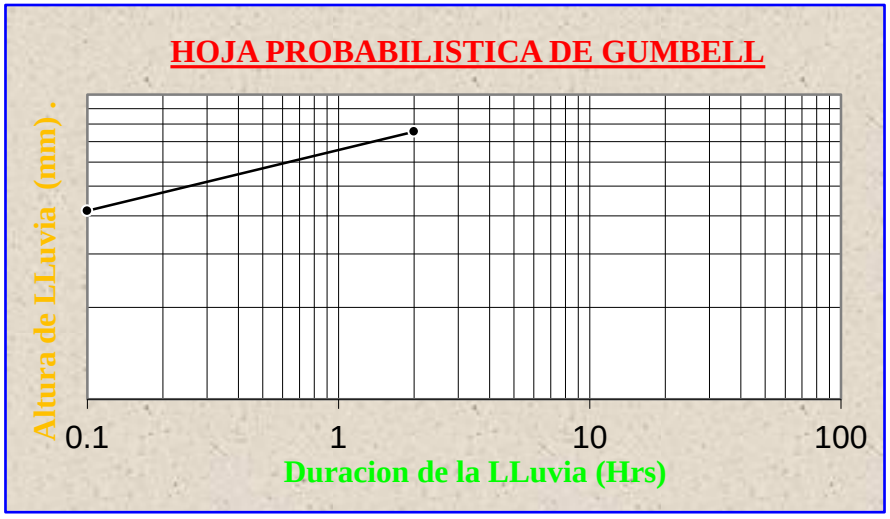
T (años) =	10
t (Hrs)	HtT (mm)
0.1	32.060
2	58.368



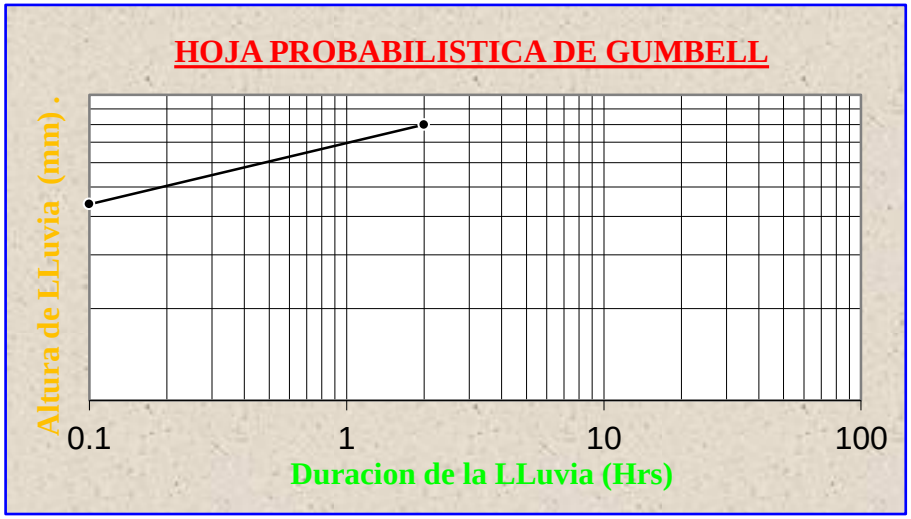
T (años) =	25
t (Hrs)	HtT (mm)
0.1	37.438
2	68.159



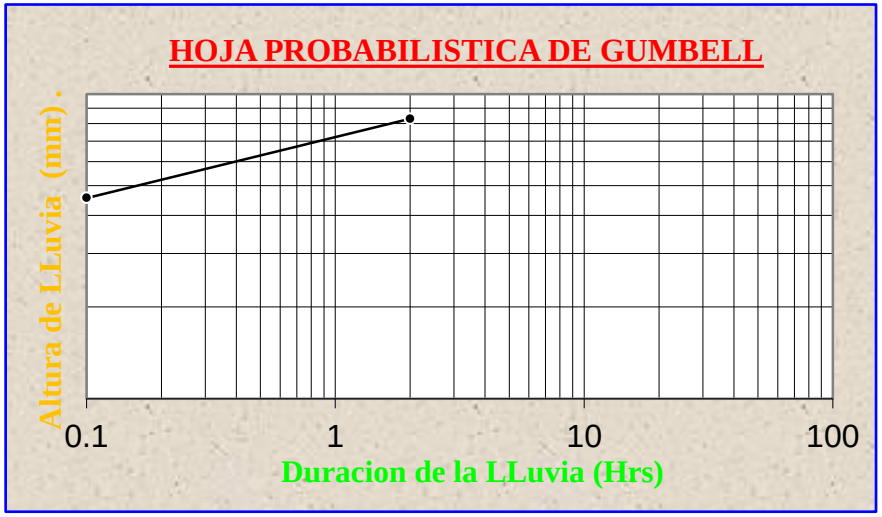
T (años) =	50
t (Hrs)	HtT (mm)
0.1	41.507
2	75.566



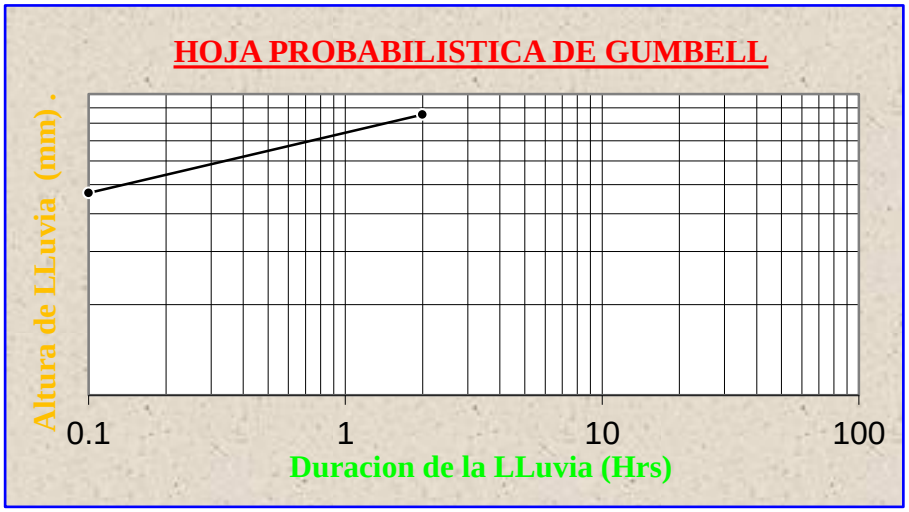
T (años) =	75
t (Hrs)	HtT (mm)
0.1	43.887
2	79.898



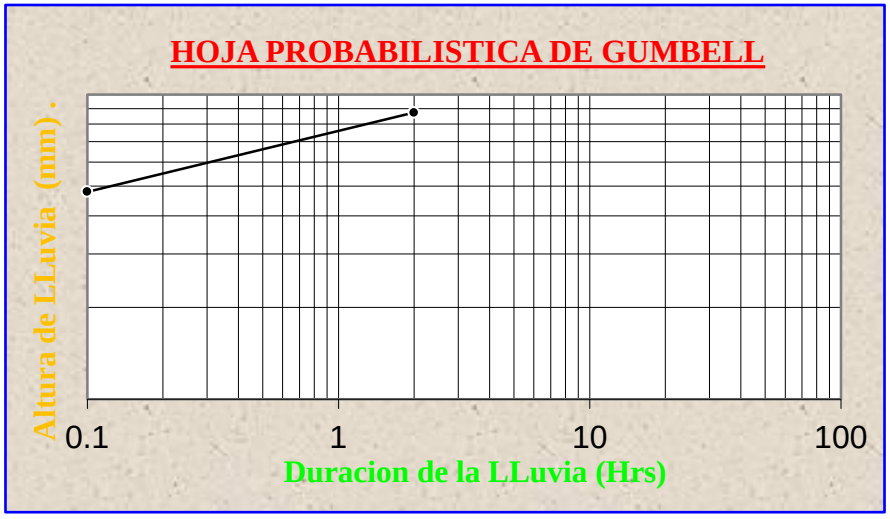
T (años) =	100
t (Hrs)	HtT (mm)
0.1	45.575
2	82.972



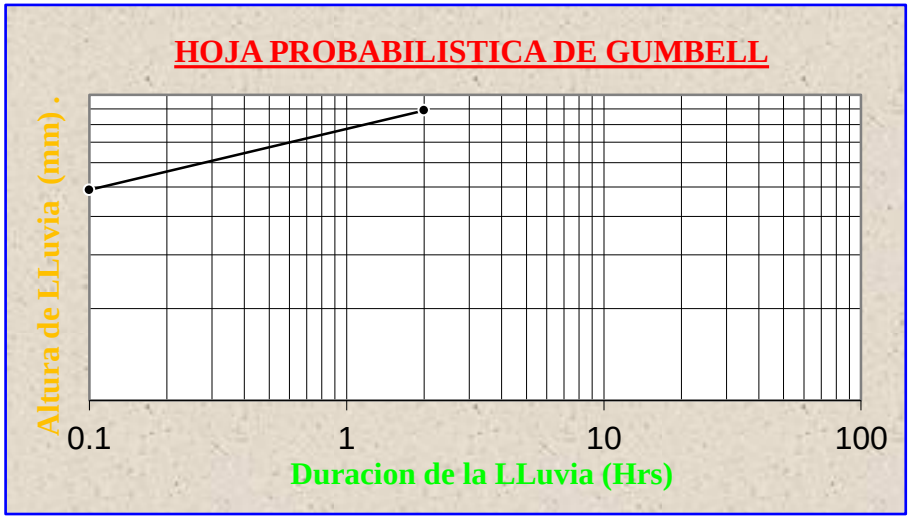
T (años) =	125
t (Hrs)	HtT (mm)
0.1	46.885
2	85.357



T (años) =	150
t (Hrs)	HtT (mm)
0.1	47.955
2	87.305



T (años) =	175
t (Hrs)	HtT (mm)
0.1	48.860
2	88.952



LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.20
Ed = 39.8208

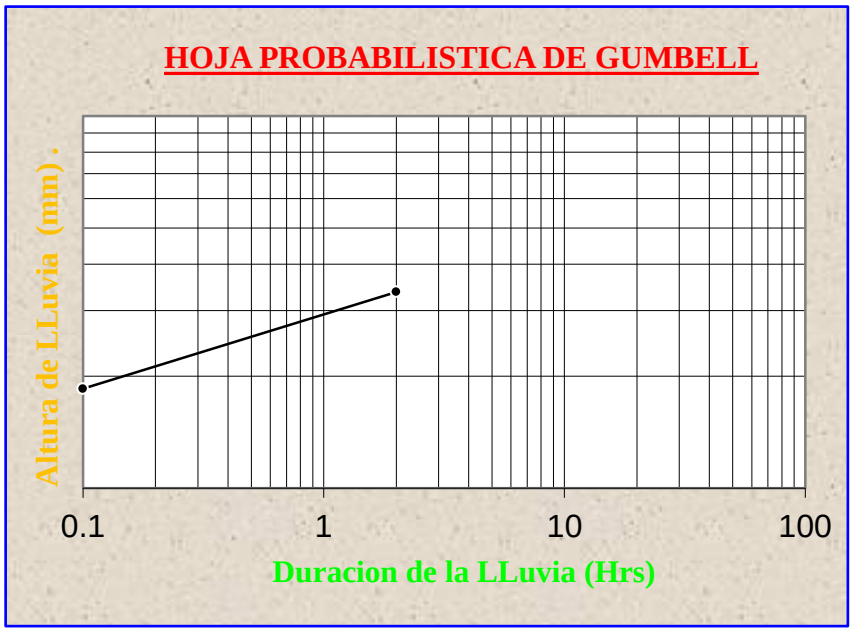
α = 12
Kd = 0.6958

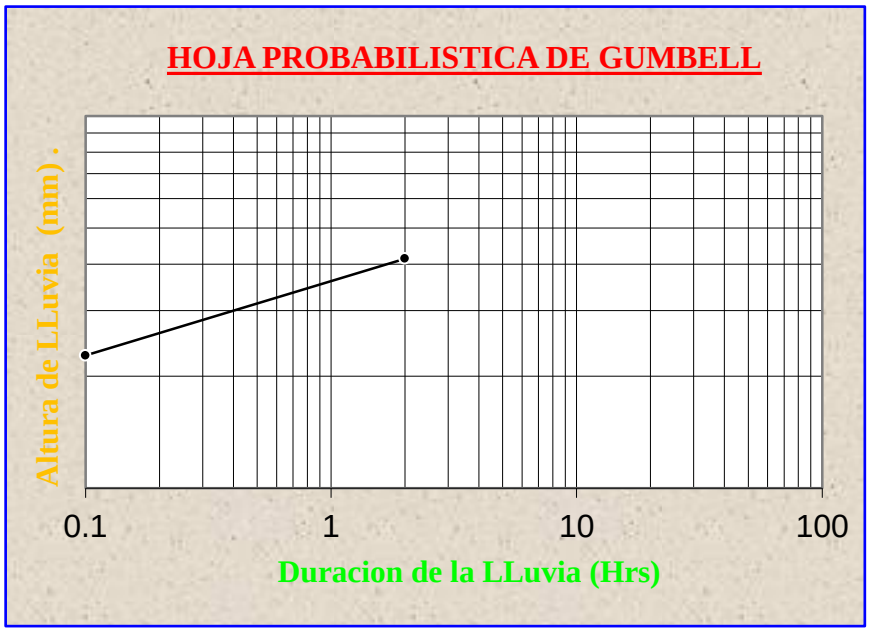
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE VALLE DE LA CONCEPCION

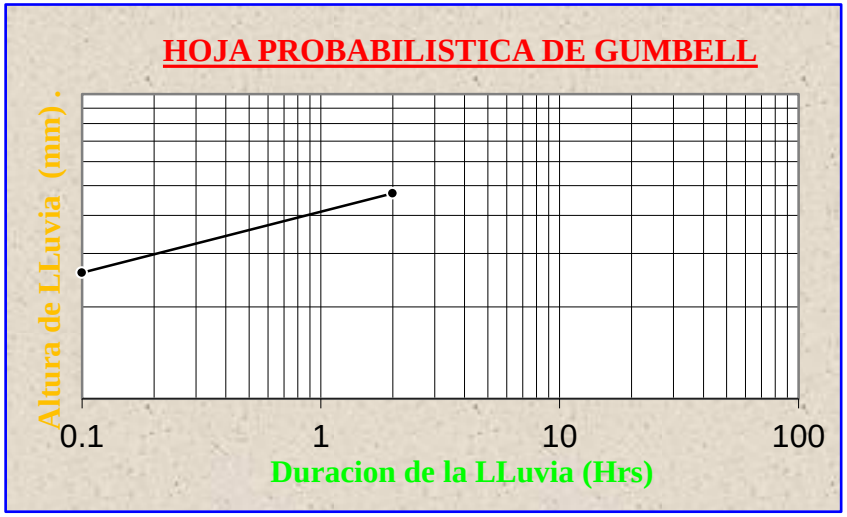
T (años) =	2
t (Hrs)	HtT (mm)
0.1	18.487
2	33.657

T (años) =	5
t (Hrs)	HtT (mm)
0.1	22.720
2	41.362

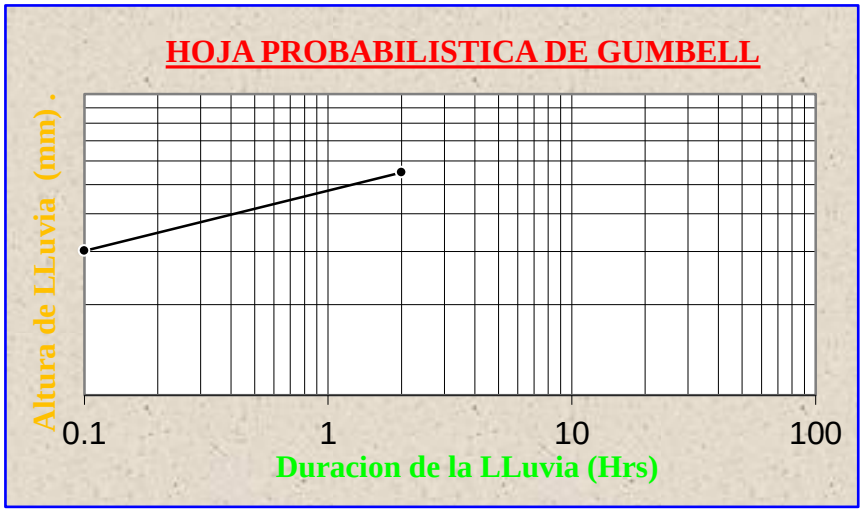




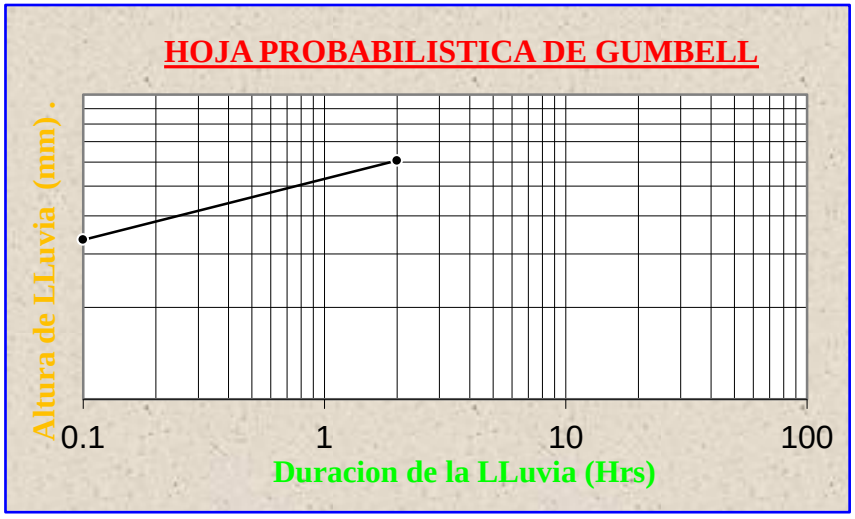
T (años) =	10
t (Hrs)	HtT (mm)
0.1	25.921
2	47.191



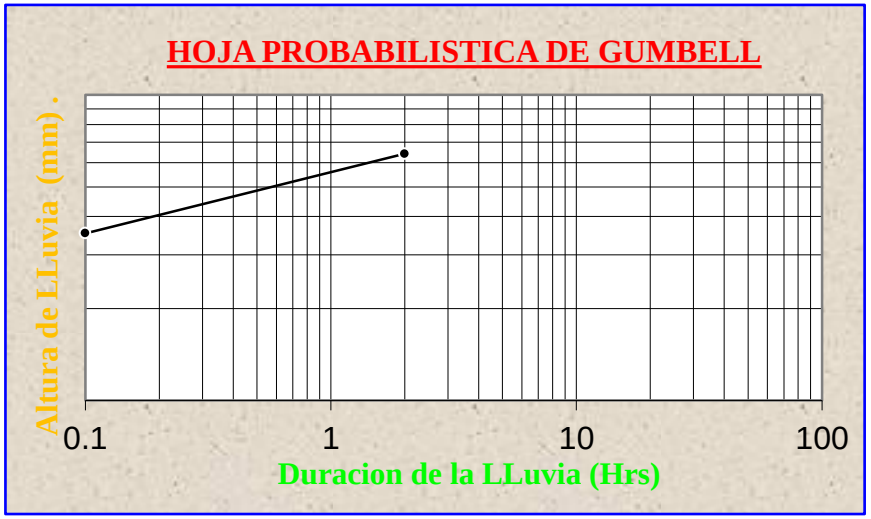
T (años) =	25
t (Hrs)	HtT (mm)
0.1	30.154
2	54.897



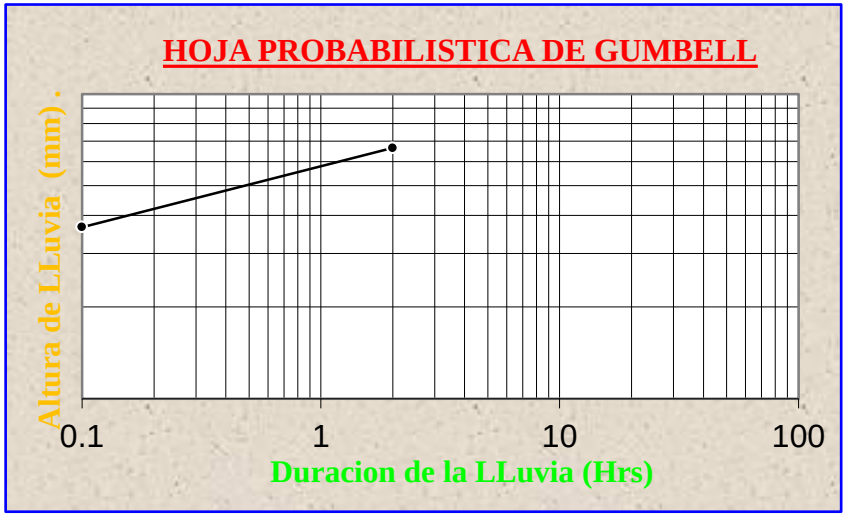
T (años) =	50
t (Hrs)	HtT (mm)
0.1	33.356
2	60.726



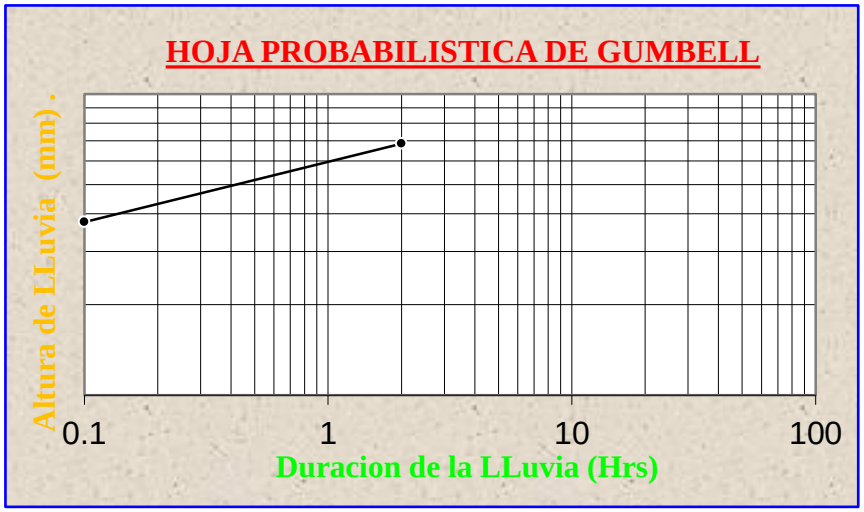
T (años) =	75
t (Hrs)	HtT (mm)
0.1	35.229
2	64.136



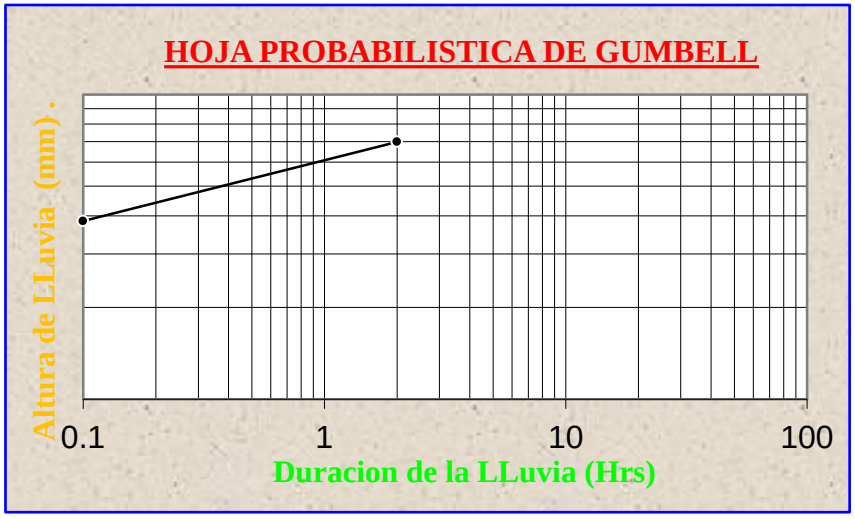
T (años) =	100
t (Hrs)	HtT (mm)
0.1	36.557
2	66.555



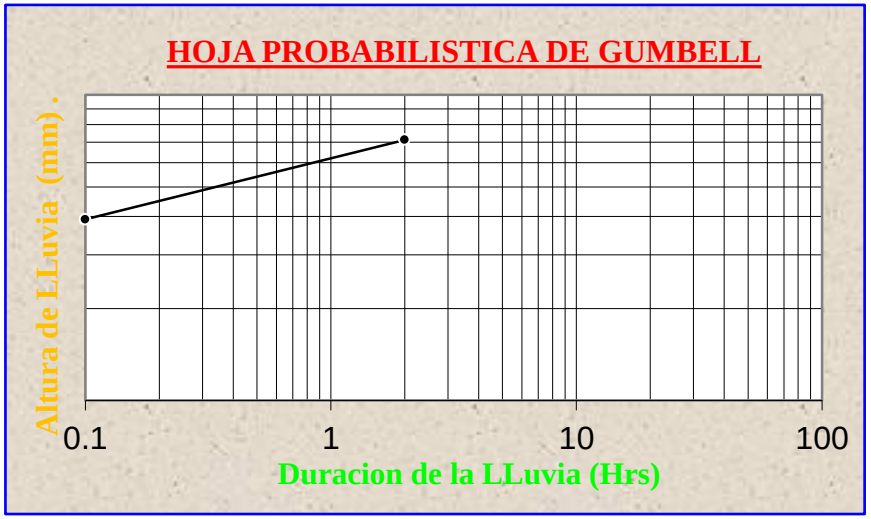
T (años) =	125
t (Hrs)	HtT (mm)
0.1	37.588
2	68.432



T (años) =	150
t (Hrs)	HtT (mm)
0.1	38.430
2	69.965



T (años) =	175
t (Hrs)	HtT (mm)
0.1	39.142
2	71.261



LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.20
Ed = 90.0521

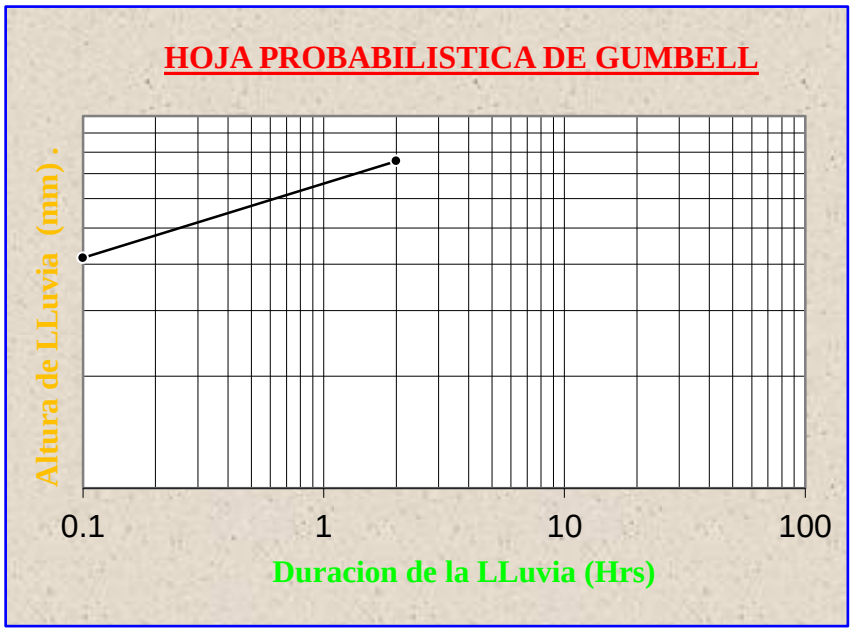
α = 12
Kd = 0.6717

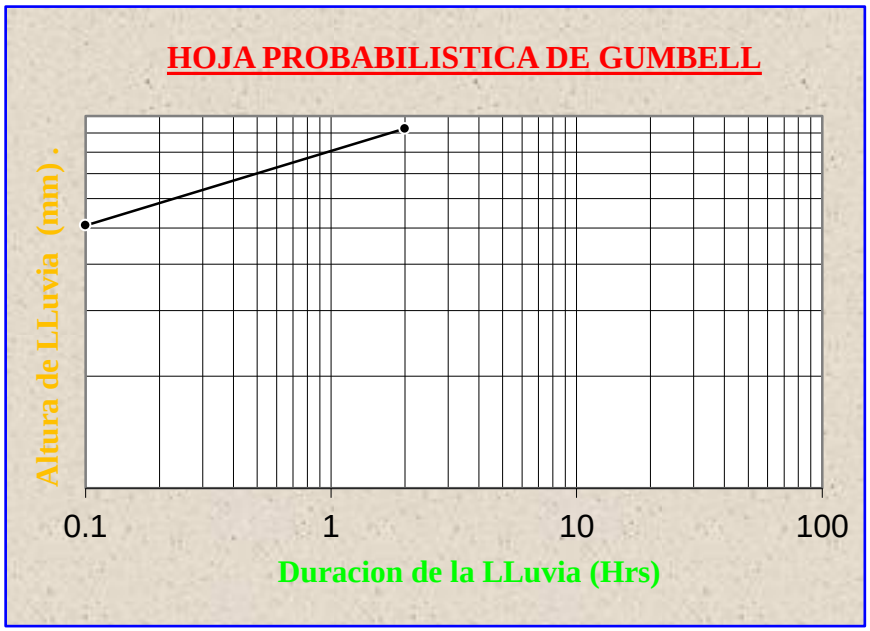
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE VILLAMONTES

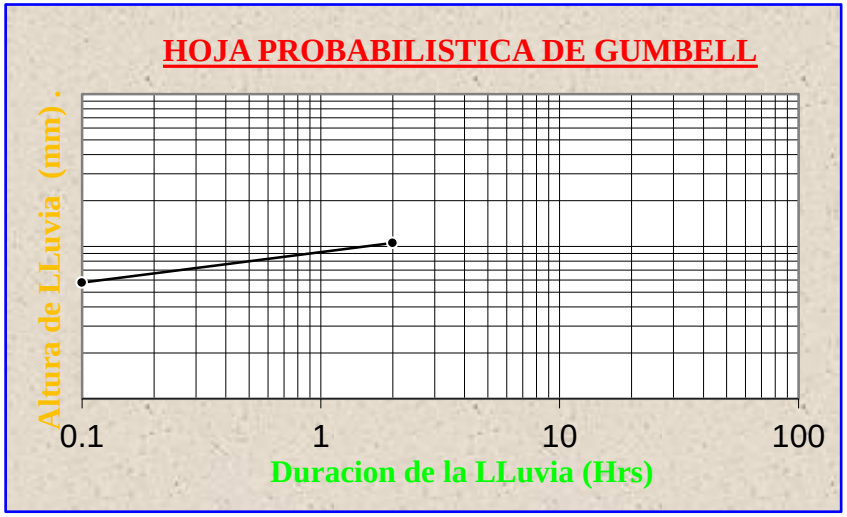
T (años) =	2
t (Hrs)	HtT (mm)
0.1	41.556
2	75.656

T (años) =	5
t (Hrs)	HtT (mm)
0.1	50.796
2	92.477

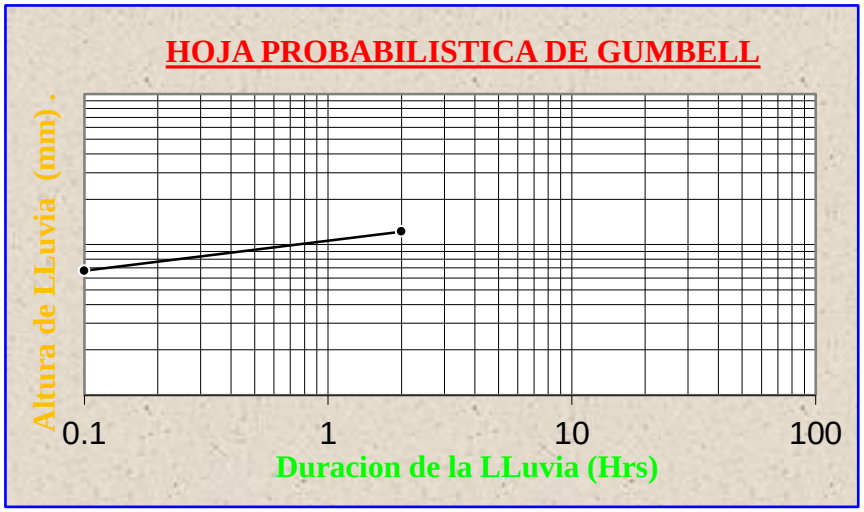




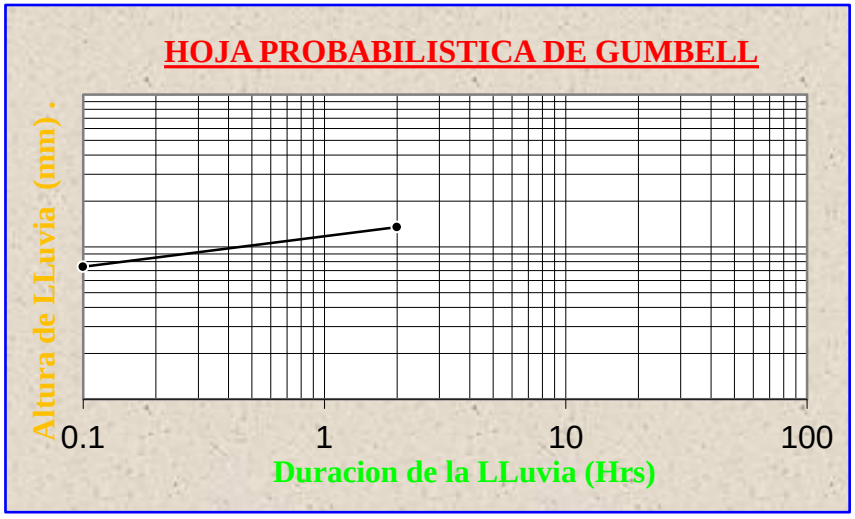
T (años) =	10
t (Hrs)	HtT (mm)
0.1	57.785
2	105.202



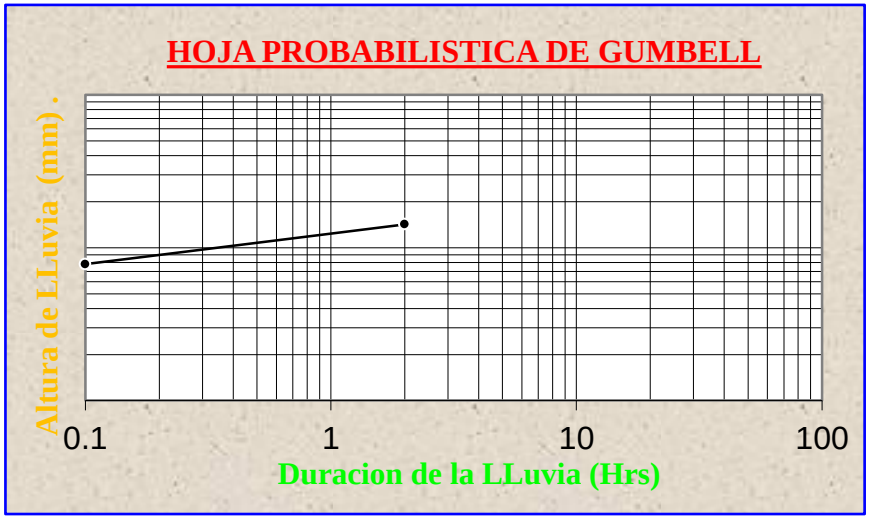
T (años) =	25
t (Hrs)	HtT (mm)
0.1	67.025
2	122.023



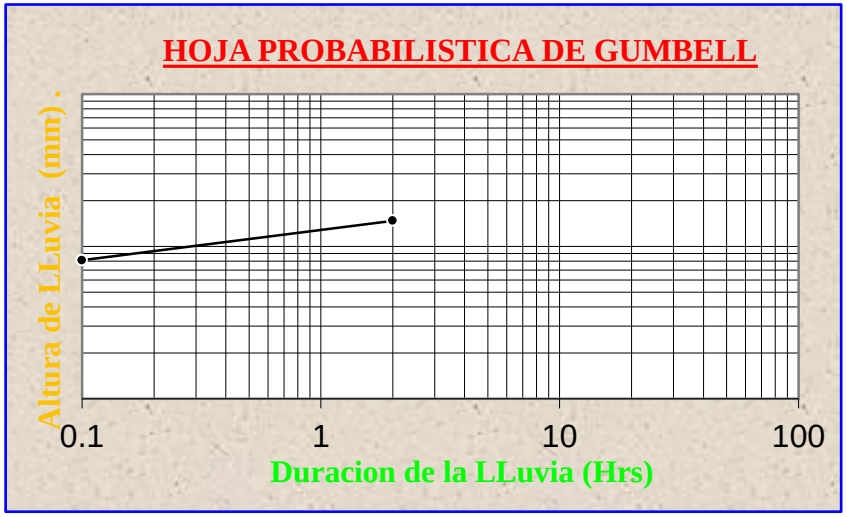
T (años) =	50
t (Hrs)	HtT (mm)
0.1	74.015
2	134.748



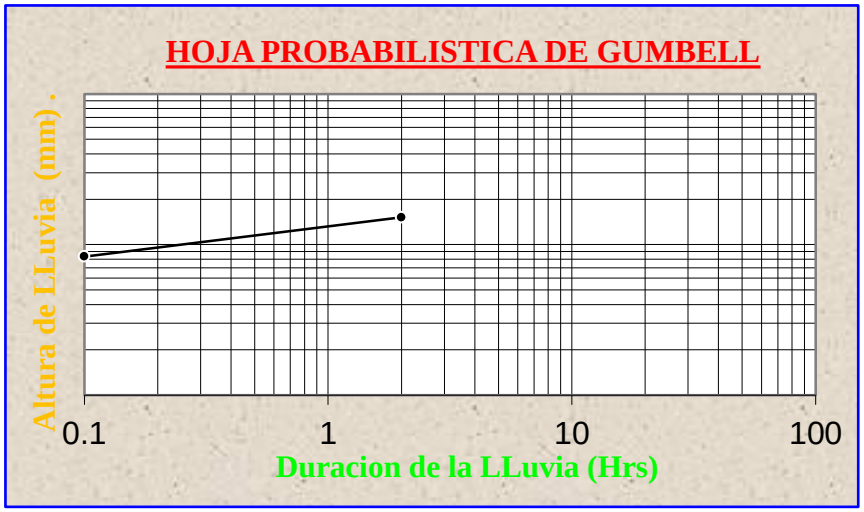
T (años) =	75
t (Hrs)	HtT (mm)
0.1	78.103
2	142.192



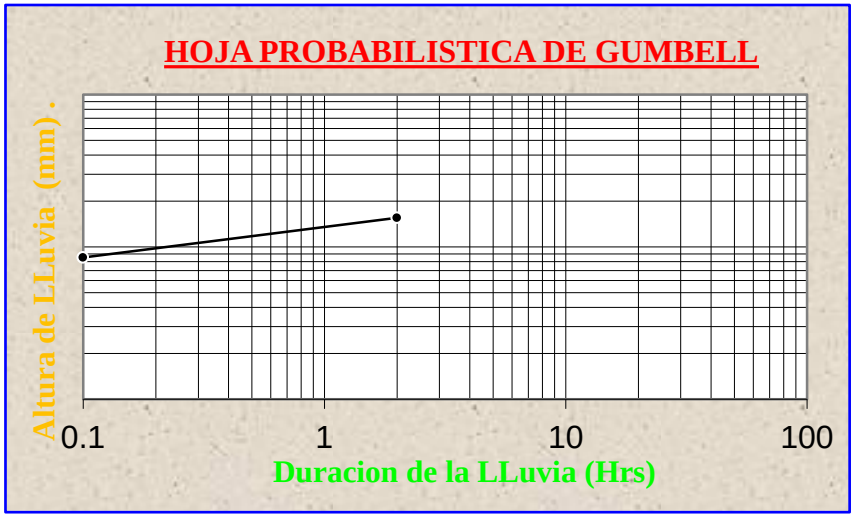
T (años) =	100
t (Hrs)	HtT (mm)
0.1	81.004
2	147.473



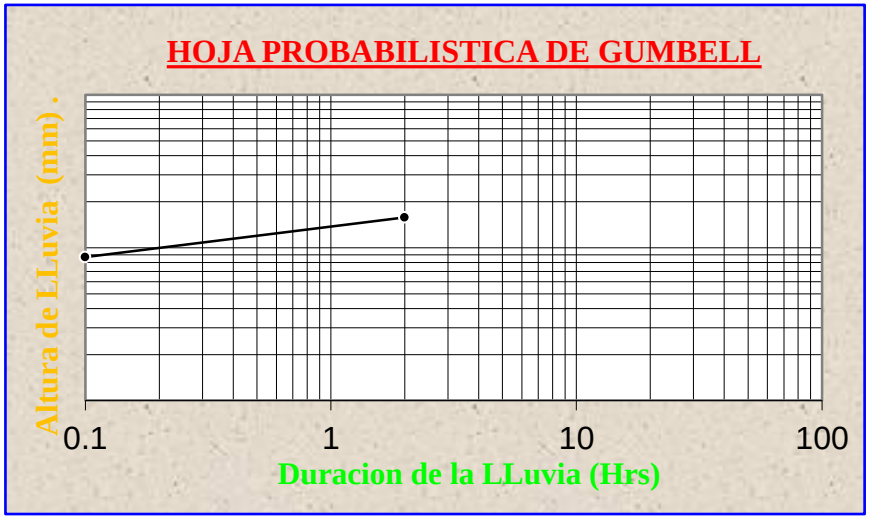
T (años) =	125
t (Hrs)	HtT (mm)
0.1	83.254
2	151.570



T (años) =	150
t (Hrs)	HtT (mm)
0.1	85.093
2	154.917



T (años) =	175
t (Hrs)	HtT (mm)
0.1	86.647
2	157.747



LLUVIAS DE DURACION MENORES A 2 hrs

Para lluvias de duracion menores a 2 Hrs se debe ajustas las mismas en un papel probabilistico de Gumbell que permite calcular la altura de lluvia horaria conociendo solo 2 puntos por lo tanto tenemos:

β = 0.20
Ed = 90.1795

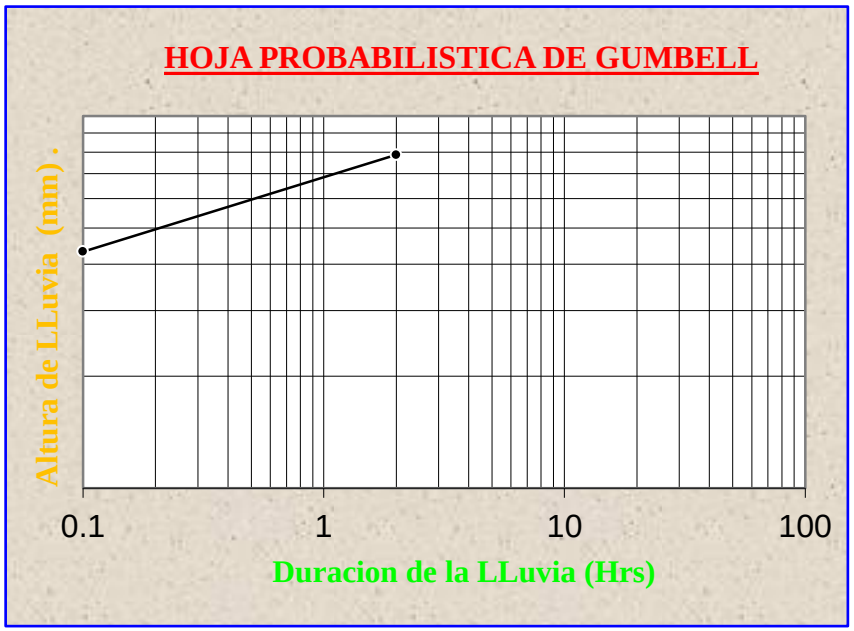
α = 12
Kd = 0.8232

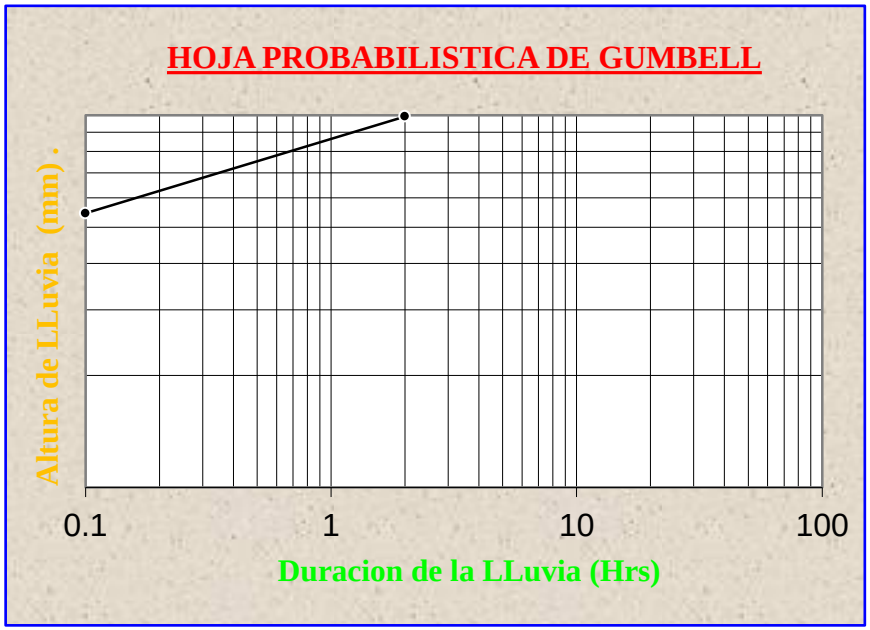
$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

CIUDAD DE YACUIBA

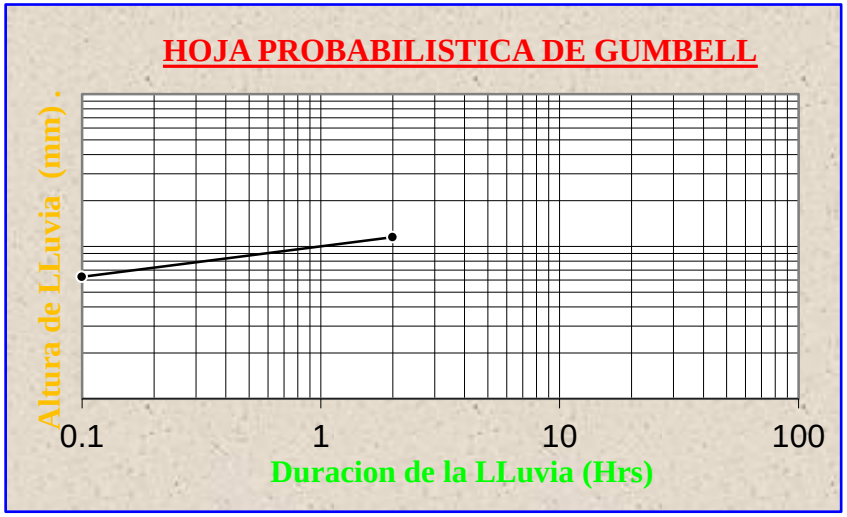
T (años) =	2
t (Hrs)	HtT (mm)
0.1	43.193
2	78.636

T (años) =	5
t (Hrs)	HtT (mm)
0.1	54.533
2	99.280

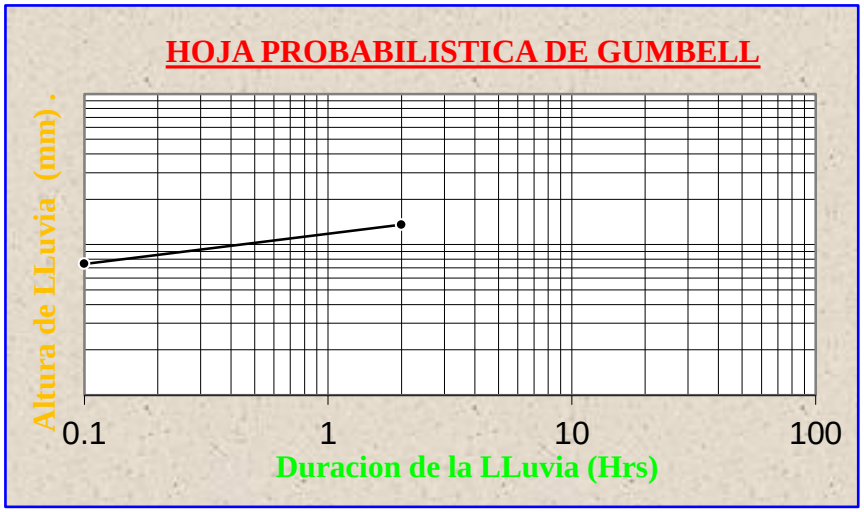




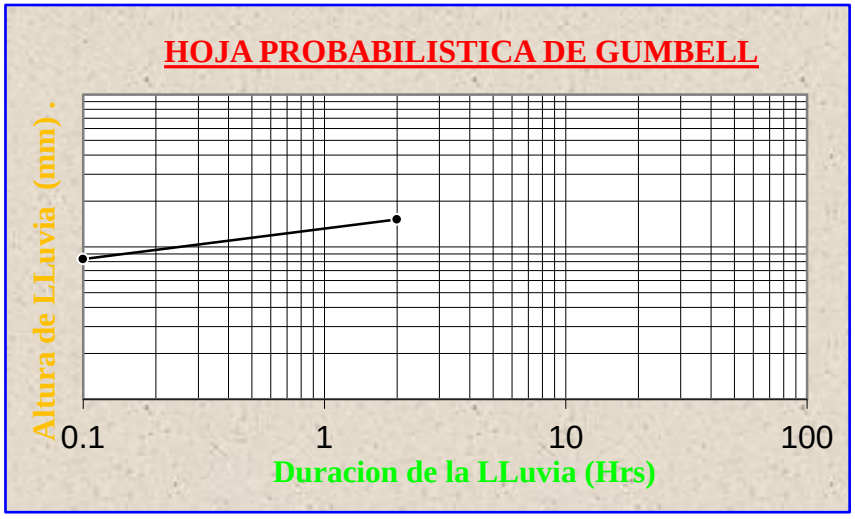
T (años) =	10
t (Hrs)	HtT (mm)
0.1	63.111
2	114.897



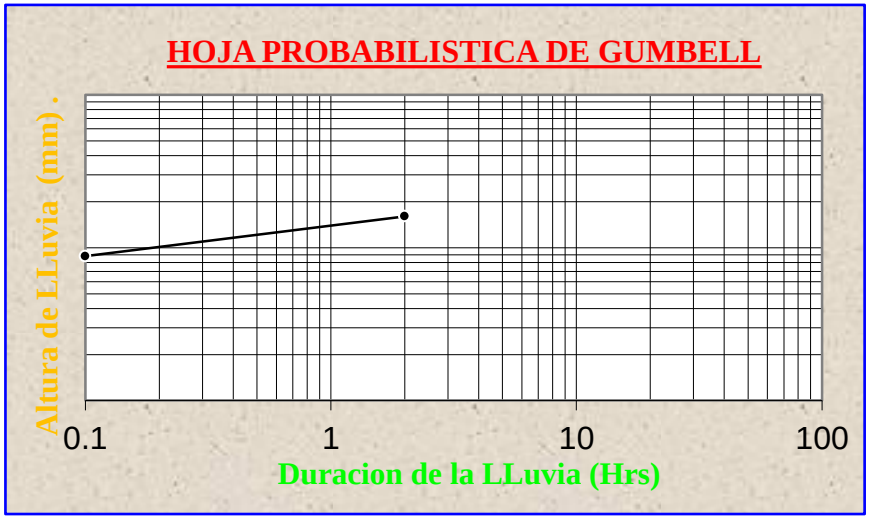
T (años) =	25
t (Hrs)	HtT (mm)
0.1	74.450
2	135.541



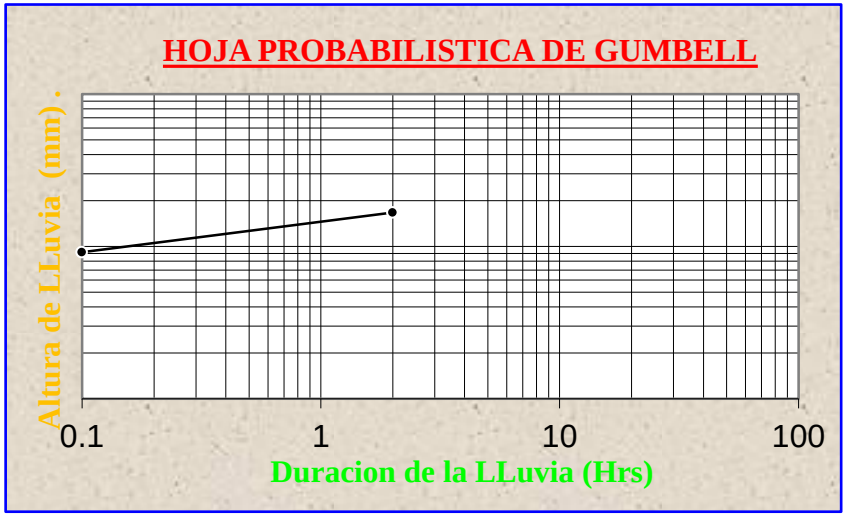
T (años) =	50
t (Hrs)	HtT (mm)
0.1	83.028
2	151.157



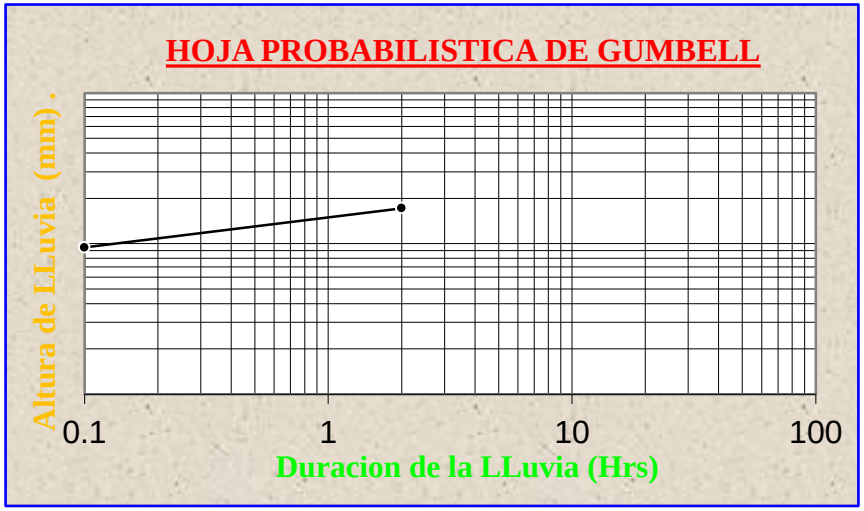
T (años) =	75
t (Hrs)	HtT (mm)
0.1	88.046
2	160.293



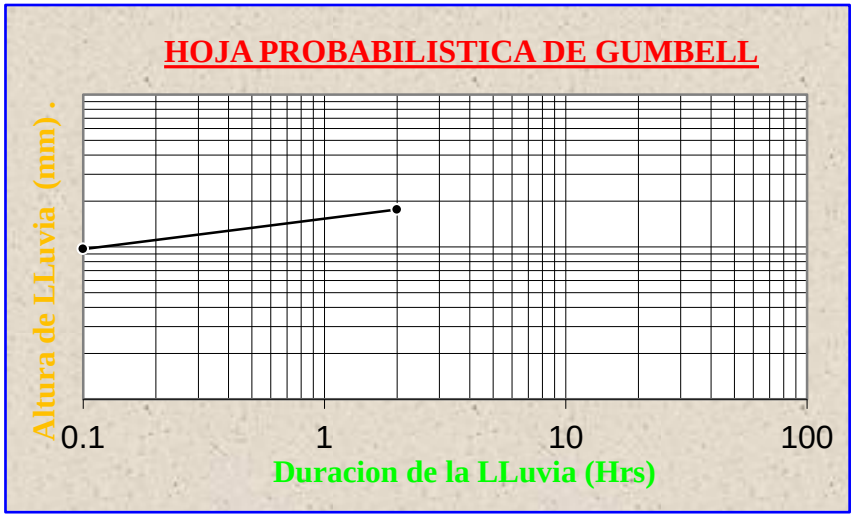
T (años) =	100
t (Hrs)	HtT (mm)
0.1	91.606
2	166.774



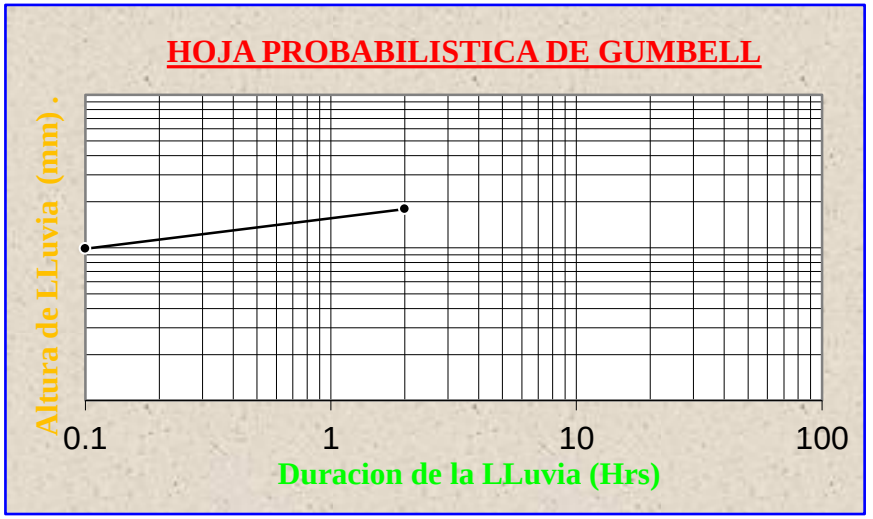
T (años) =	125
t (Hrs)	HtT (mm)
0.1	94.367
2	171.801



T (años) =	150
t (Hrs)	HtT (mm)
0.1	96.623
2	175.909



T (años) =	175
t (Hrs)	HtT (mm)
0.1	98.531
2	179.382



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las lluvias maximas anuales:

Año	Estaciones para la Ciudad de San Lorenzo					
	Coimata	Sella Qdas	Tomatas Grande	San Lorenzo	Tomatitas	Canasmoro
1	45.3					
2	48.3					
3	60.5					
4	42.4					
5	43.1					
6	53.2					
7	60.7					
8	70.2					
9	60	60.3				
10	62.1	50.1				
11	58.2	65.8				
12	46.2	45				
13	55.2	88.5				
14	71.6	40		25		
15	60	40		23.8		
16	56.4	63		22.3		
17	61.4	80.5		25		
18	48.2	52		23		45.5
19	58.2	62.5		31		38
20	66.6	72.4		21.3		29
21	56.8	42.3	70.3	44		29
22	51	55.6	40.5	25.3		42.5
23	45.8	32	60.3	42.4		34
24	70.2	63.4	50.3	22.6	64	32.6
25	56.4	76.5	60.8	21	53	33.1
26	46.2	43.1	40.6	26	74	40.5
27	59.8	78	30.4	26	64	49
28	53.4	40.5	60	25	62	42.5
29	52.6	80.4	50.4	57.2	58	29
30	72.4	70.6	70.3	36.2	47	56.5

Calculos de las Medidas de Distribucion:

Media =	56.41	59.20	53.39	29.24	60.29	38.55
Desviacion =	8.56	16.22	13.31	10.02	8.69	8.54
Varianza =	73.19	263.20	177.22	100.41	75.57	72.87
N° de Datos =	30	22	10	17	7	13

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \bar{x} - 0.45\,S$$

Moda =	52.56	51.90	47.40	24.73	56.37	34.71

$$K = \frac{S}{0.557 * E}$$

Caracteristica	0.29	0.56	0.50	0.73	0.28	0.44

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° =	1576.91	1141.89	473.99	420.44	394.62	451.26
K*N° =	8.77	12.35	5.04	12.37	1.94	5.74

Moda Ponderada:

$$E_d = \frac{\sum E_i * n_i}{\sum n_i} =$$ 45.042

Caracteristica Ponderada:

$$Kd = \frac{\sum K_i * n_i}{\sum n_i} =$$ 0.467

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- Ed = Moda Ponderada
- Kd = Caracteristica Ponderada
- T = Periodo de Retorno
- hdt = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	51.37
5	59.73
10	66.06
25	74.42
50	80.75
75	84.45
100	87.08
125	89.11
150	90.78
175	92.19
200	93.40
250	95.44

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota: Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Donde:

- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.2
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

Para A_c > 20 km^2 ⇒ α = 12

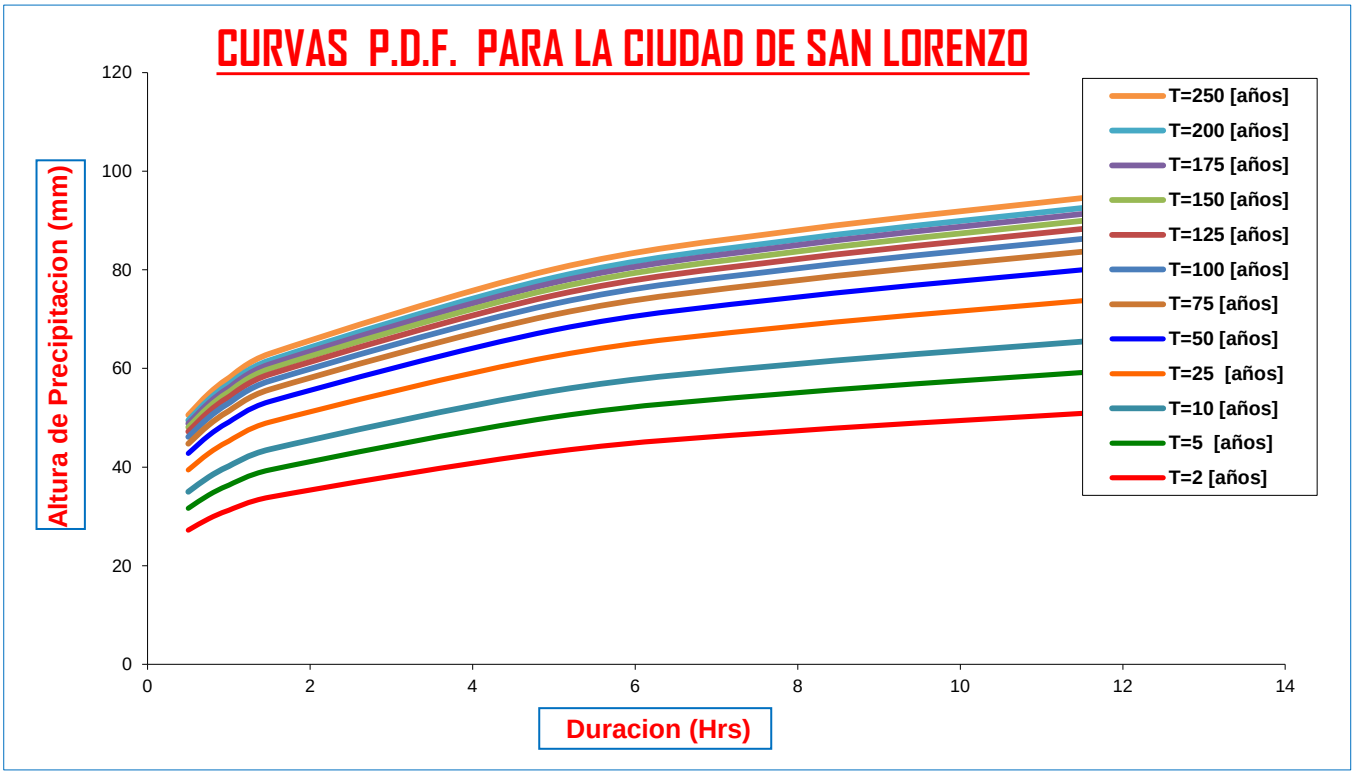
Para A_c < 20 km^2 ⇒ α = 2

Aplicando la Formula tenemos las lluvias Maxima Horarias:

⇒ β = 0.2 ⇒ α = 12 **Valor Adoptado**

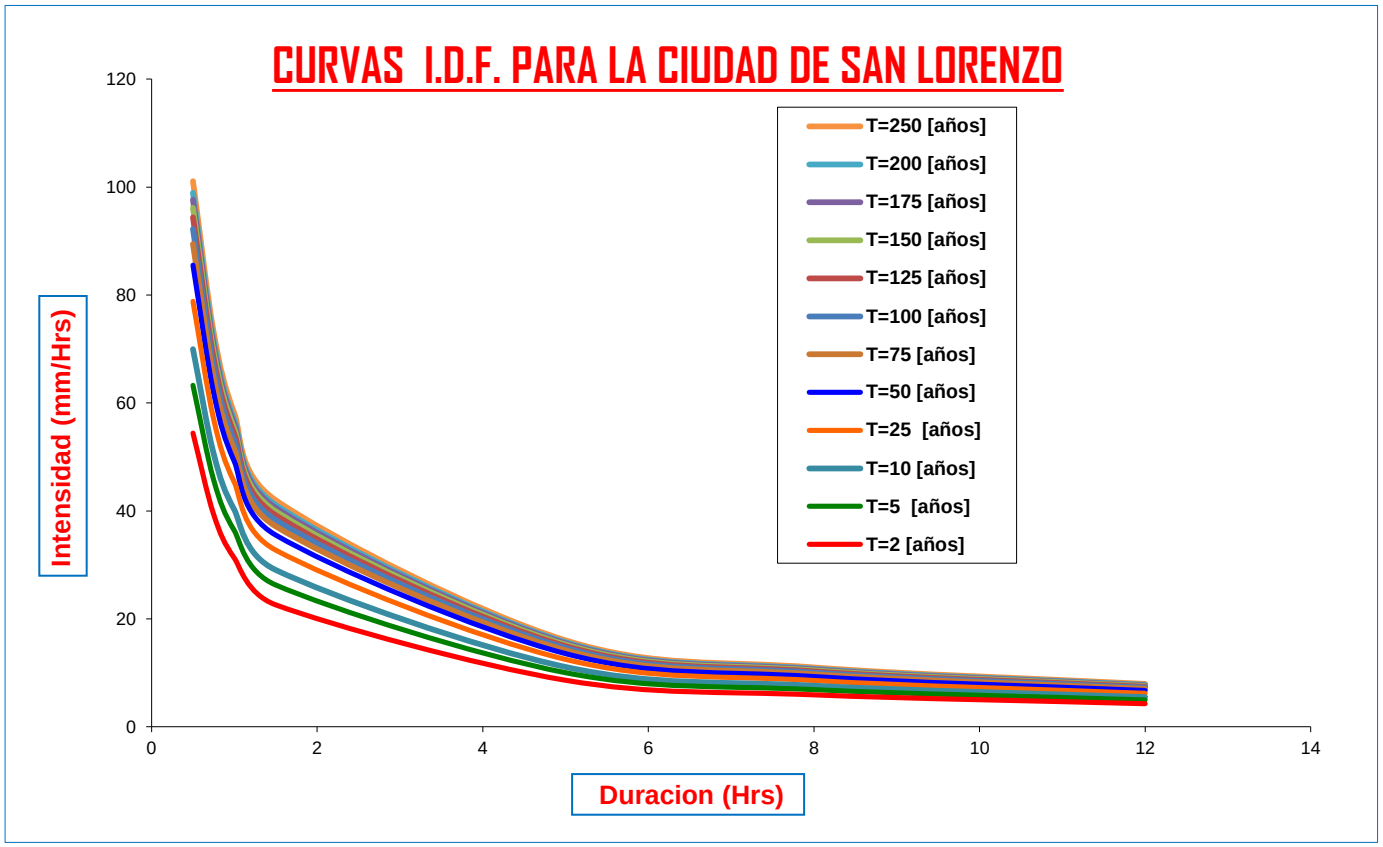
⇒ E_d = 45.04 ⇒ K_d = 0.47

Periodo de Retorno	Duracion de lluvia en (mm)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	27.21	29.50	31.25	33.89	43.12	47.37	51.37
5	31.64	34.31	36.34	39.41	50.14	55.08	59.73
10	34.99	37.94	40.19	43.58	55.45	60.91	66.06
25	39.42	42.75	45.28	49.10	62.47	68.63	74.42
50	42.77	46.38	49.13	53.28	67.78	74.46	80.75
75	44.73	48.50	51.38	55.72	70.89	77.87	84.45
100	46.12	50.01	52.97	57.45	73.09	80.30	87.08
125	47.20	51.18	54.21	58.79	74.80	82.17	89.11
150	48.08	52.14	55.23	59.89	76.20	83.71	90.78
175	48.82	52.95	56.08	60.82	77.38	85.01	92.19
200	49.47	53.65	56.82	61.62	78.40	86.13	93.40
250	50.55	54.82	58.06	62.97	80.11	88.01	95.44

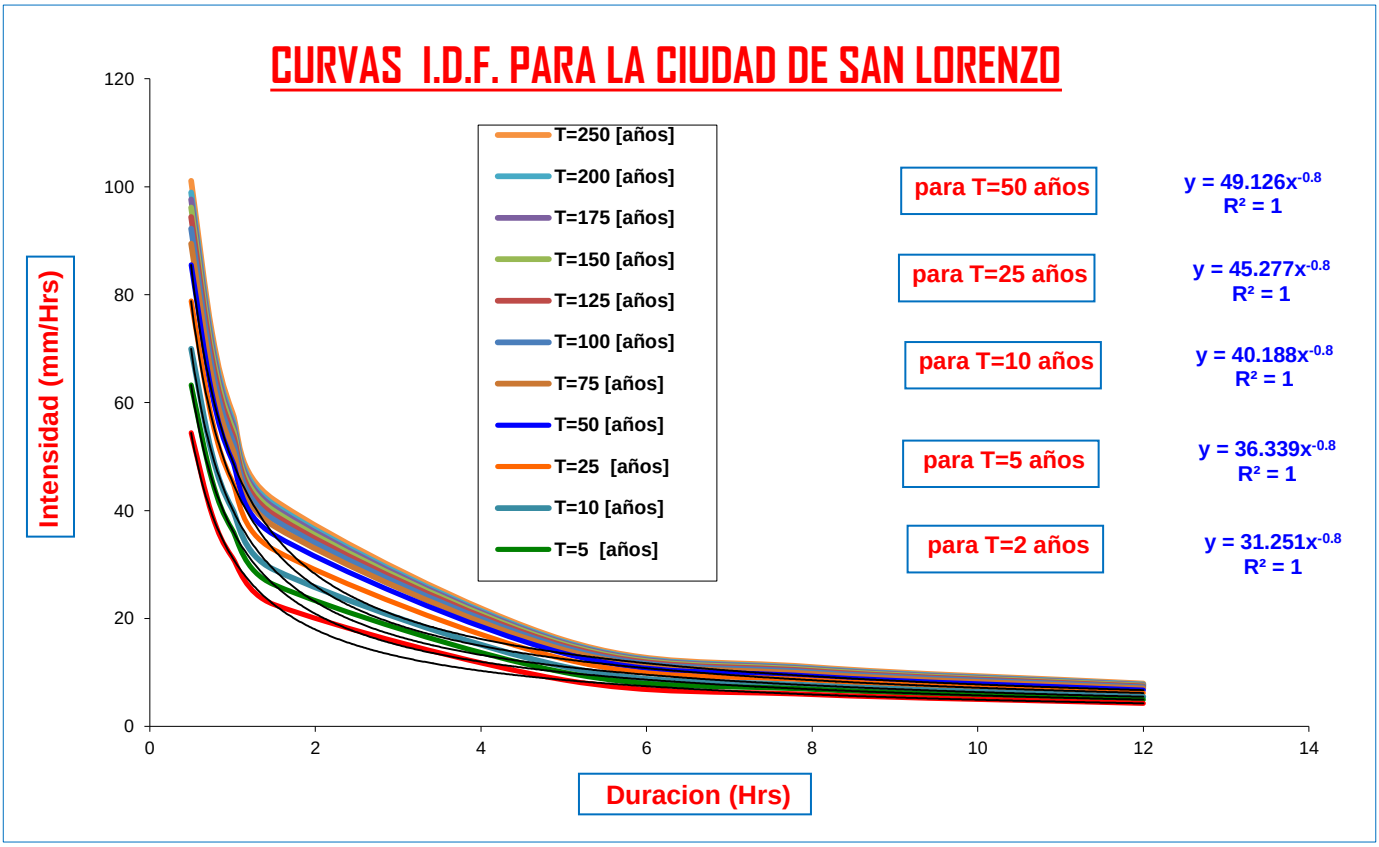


Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	54.41	39.34	31.25	22.59	8.62	5.92	4.28
5	63.27	45.74	36.34	26.27	10.03	6.88	4.98
10	69.97	50.59	40.19	29.06	11.09	7.61	5.50
25	78.83	56.99	45.28	32.73	12.49	8.58	6.20
50	85.53	61.84	49.13	35.52	13.56	9.31	6.73
75	89.45	64.67	51.38	37.14	14.18	9.73	7.04
100	92.23	66.68	52.97	38.30	14.62	10.04	7.26
125	94.39	68.24	54.21	39.20	14.96	10.27	7.43
150	96.16	69.52	55.23	39.93	15.24	10.46	7.56
175	97.65	70.60	56.08	40.55	15.48	10.63	7.68
200	98.94	71.53	56.82	41.08	15.68	10.77	7.78
250	101.09	73.09	58.06	41.98	16.02	11.00	7.95



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las Precipitaciones maximas anuales:

Año	Estaciones para la Ciudad de Bermejo		
	Bermejo	El Salado	Arrozales
1	80.5		
2	40		
3	53.4		
4	108.9		
5	85.4		
6	151.5		
7	68		
8	88.8		
9	100		
10	92.7		
11	91		
12	117		
13	74.4		
14	70		80.5
15	98		40
16	86.1	210	53.4
17	84.4	100.6	108.9
18	64.7	220.7	85.4
19	93.1	44.7	151.5
20	68.9	180.7	68
21	44	87.7	88.8
22	99.5	82.2	100
23	94.8	91.5	92.7
24	47.9	108.5	91
25	137.2	68.5	117
26	104.2	116.5	74.4
27	101.3	112.5	70
28	72.3	165.5	98
29	131.7	109.5	86.1

Calculos de las Medidas de Distribucion:

Media =	87.92	121.36	87.86
Desviacion =	26.56	52.82	25.90
Varianza =	705.27	2789.48	670.81
N° de Datos =	29	14	16

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \bar{x} - 0.45\,S$$

Moda = 75.97 97.60 76.20

$$K = \frac{S}{0.557 * E}$$

Caracteristica 0.63 0.97 0.61

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° = 2203.13 1366.36 1219.22

K*N° = 18.20 13.60 9.76

Moda Ponderada: $E_d = \frac{\sum E_i * n_i}{\sum n_i} =$ 81.165

Caracteristica Ponderada: $Kd = \frac{\sum K_i * n_i}{\sum n_i} =$ 0.705

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- Ed = Moda Ponderada
- Kd = Caracteristica Ponderada
- T = Periodo de Retorno
- hdt = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	98.38
5	121.13
10	138.35
25	161.10
50	178.31
75	188.38
100	195.53
125	201.07
150	205.59
175	209.42
200	212.74
250	218.28

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota: Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Donde:

- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.02
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

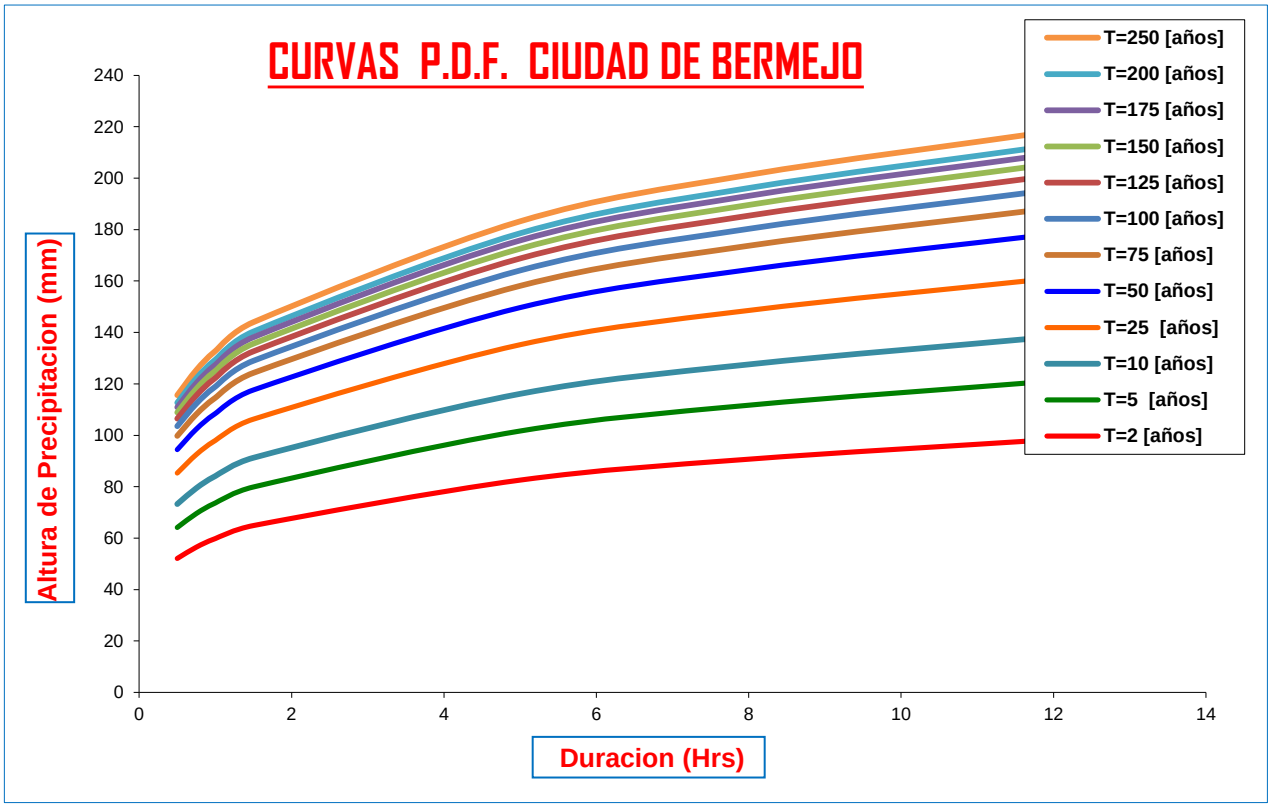
Para	A_c >	20	km^2	⇒	α =	12
Para	A_c <	20	km^2	⇒	α =	2

Aplicando la Formula tenemos las lluvias Maxima Horarias:

⇒ β = 0.2 ⇒ α = 12 **Valor Adoptado**

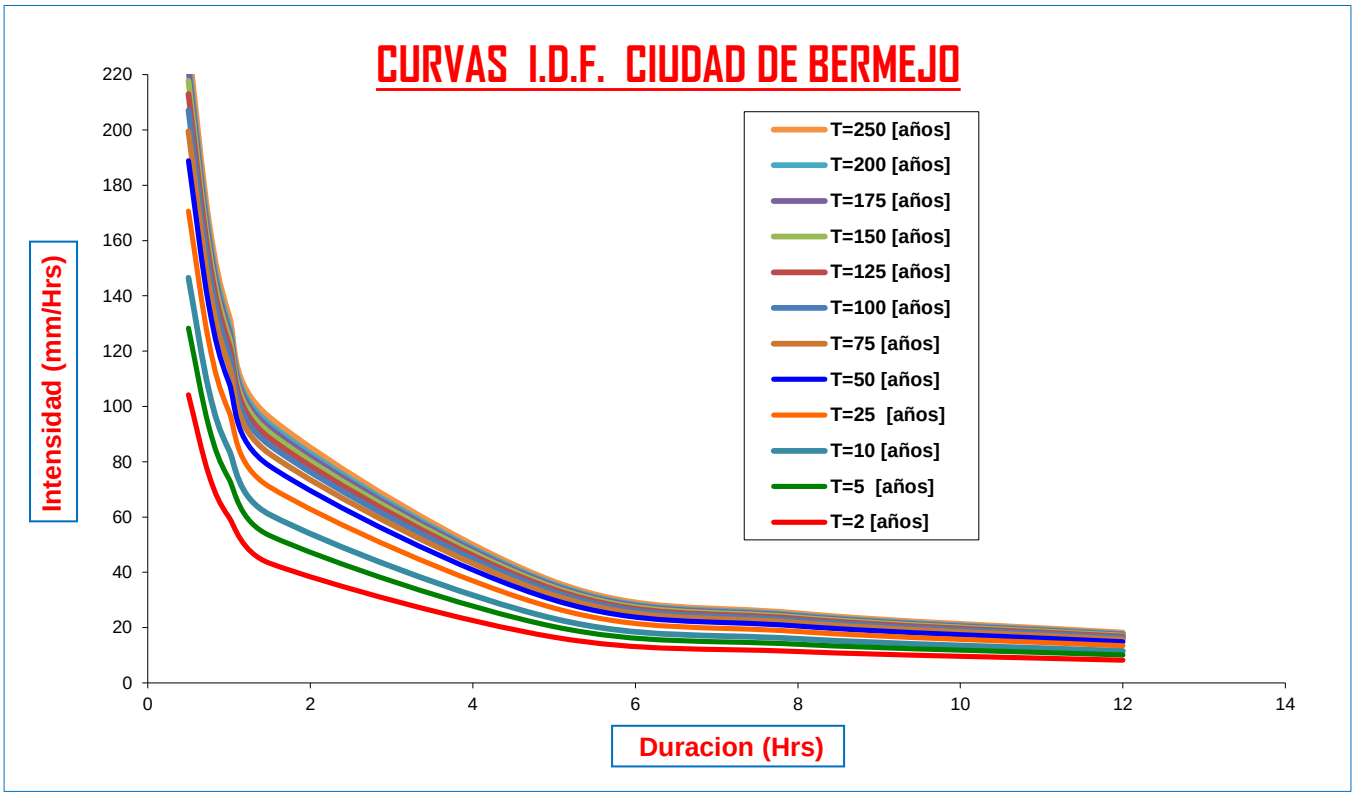
⇒ E_d = 81.16 ⇒ K_d = 0.70

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	52.10	56.50	59.85	64.91	82.58	90.71	98.38
5	64.15	69.57	73.69	79.92	101.68	111.70	121.13
10	73.27	79.46	84.16	91.27	116.12	127.57	138.35
25	85.32	92.53	98.01	106.29	135.22	148.55	161.10
50	94.44	102.41	108.48	117.64	149.67	164.42	178.31
75	99.77	108.20	114.60	124.29	158.12	173.71	188.38
100	103.55	112.30	118.95	129.00	164.12	180.30	195.53
125	106.49	115.48	122.32	132.65	168.77	185.41	201.07
150	108.89	118.08	125.08	135.64	172.57	189.58	205.59
175	110.91	120.28	127.41	138.17	175.79	193.11	209.42
200	112.67	122.19	129.42	140.36	178.57	196.17	212.74
250	115.60	125.37	132.79	144.01	183.22	201.28	218.28

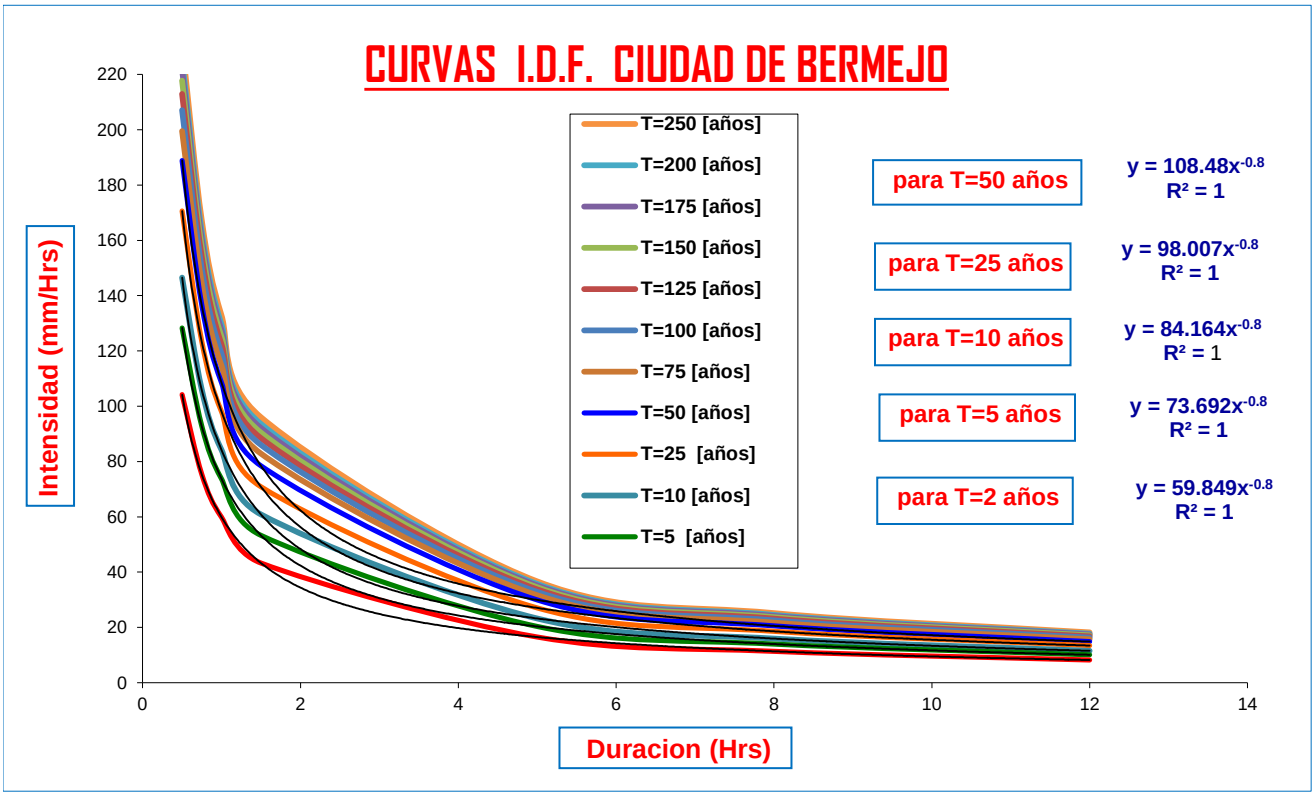


Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	104.20	75.34	59.85	43.27	16.52	11.34	8.20
5	128.31	92.76	73.69	53.28	20.34	13.96	10.09
10	146.54	105.94	84.16	60.85	23.22	15.95	11.53
25	170.64	123.37	98.01	70.86	27.04	18.57	13.42
50	188.87	136.55	108.48	78.43	29.93	20.55	14.86
75	199.54	144.26	114.60	82.86	31.62	21.71	15.70
100	207.11	149.73	118.95	86.00	32.82	22.54	16.29
125	212.98	153.98	122.32	88.44	33.75	23.18	16.76
150	217.77	157.44	125.08	90.43	34.51	23.70	17.13
175	221.83	160.38	127.41	92.11	35.16	24.14	17.45
200	225.34	162.92	129.42	93.57	35.71	24.52	17.73
250	231.21	167.16	132.79	96.01	36.64	25.16	18.19



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las Precipitaciones maximas anuales:

Año	Estaciones para la Ciudad de Carapari			
	Carapari	Palos Blancos	Sachapera	Itau
1		70.3		
2		100	160.5	
3		29.9	186	
4		74.3	108.4	
5		53	60	
6		57.3	84.2	
7		55	120	
8		54.5	156	
9		40	130	
10		62	105	
11		92	105	57.5
12		98.6	81.4	47
13		89.3	175	80
14		41.5	130.5	70.3
15		50.1	60.5	99
16		77	90.7	91
17	234.5	109.3	145.6	160
18	105.5	88.7	126.2	72
19	140.2	38.4	158.8	60
20	160	60.1	92.6	72
21	89	50.7	60	63
22	90	82.3	58.3	162
23	71	60.2	140	50
24	55.5	57.5	118	60
25	69.5	63.7	115.5	78.1
26	156	70.2	113.5	80.3
27	116	65.2	83	70.9
28	80	63.3	71.5	104
29	78	79	180	67
30	43	53.2	75.6	67.5

Calculos de las Medidas de Distribucion:

Media =	106.30	66.22	113.51	80.58
Desviacion =	51.35	19.61	38.16	31.11
Varianza =	2636.80	384.38	1456.32	968.07
N° de Datos =	14	30	29	20

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \overline{x} - 0.45\,S$$

Moda =	83.19	57.40	96.34	66.58

$$K = \frac{S}{0.557 * E}$$

Caracteristica	1.11	0.61	0.71	0.84

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° =	1164.70	1721.93	2793.79	1331.58
K*N° =	15.51	18.40	20.62	16.78

Moda Ponderada: $E_d = \frac{\sum E_i * n_i}{\sum n_i} =$ 75.398

Caracteristica Ponderada: $Kd = \frac{\sum K_i * n_i}{\sum n_i} =$ 0.767

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- Ed = Moda Ponderada
- Kd = Caracteristica Ponderada
- T = Periodo de Retorno
- hdt = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	92.80
5	115.81
10	133.22
25	156.22
50	173.63
75	183.81
100	191.03
125	196.64
150	201.21
175	205.08
200	208.44
250	214.04

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota: Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Donde:

- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.02
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

Para A_c > 20 km^2 ⇒ α = 12

Para A_c < 20 km^2 ⇒ α = 2

Aplicando la Formula tenemos las lluvias Maxima Horarias:

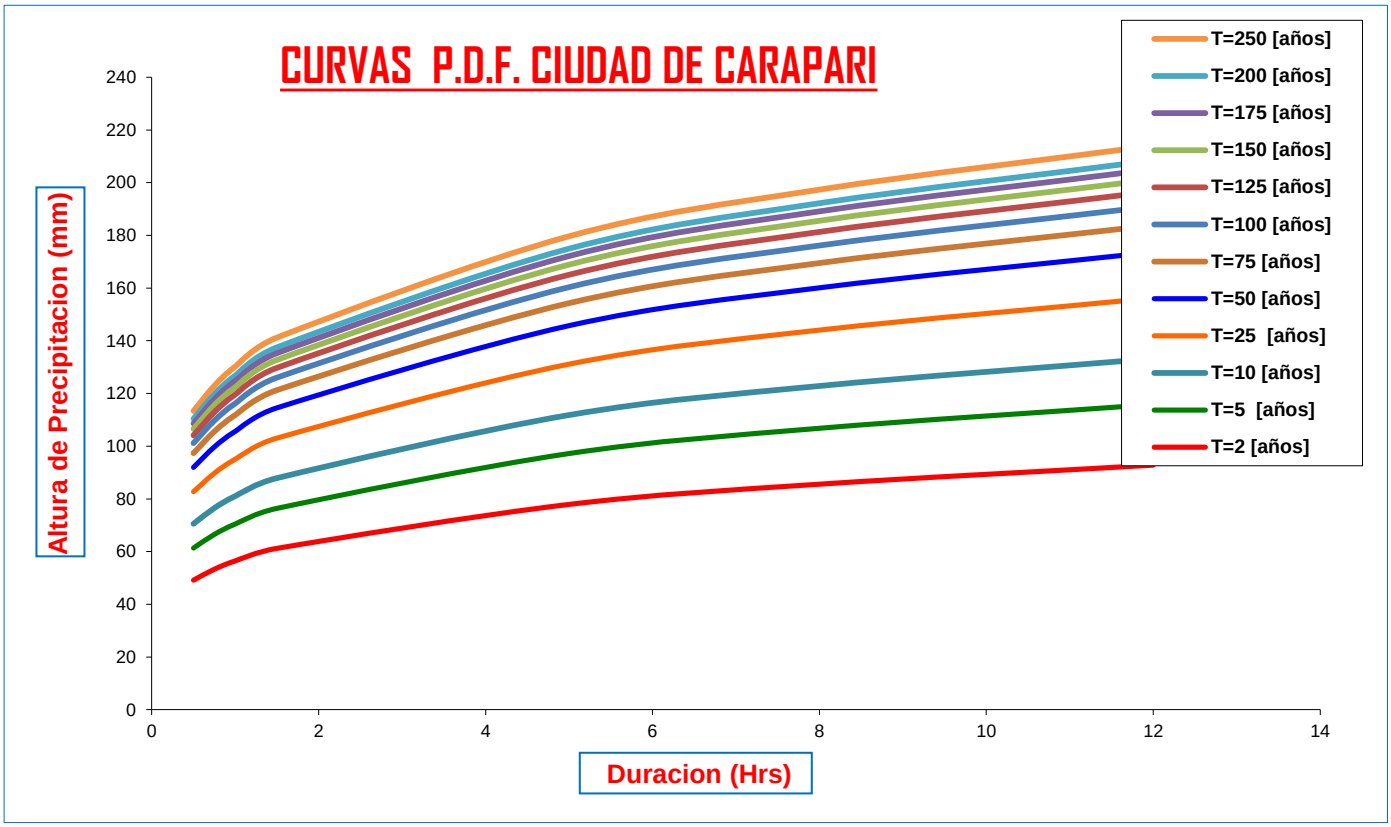
⇒ β = 0.2

⇒ E_d = 75.40

⇒ α = 12 **Valor Adoptado**

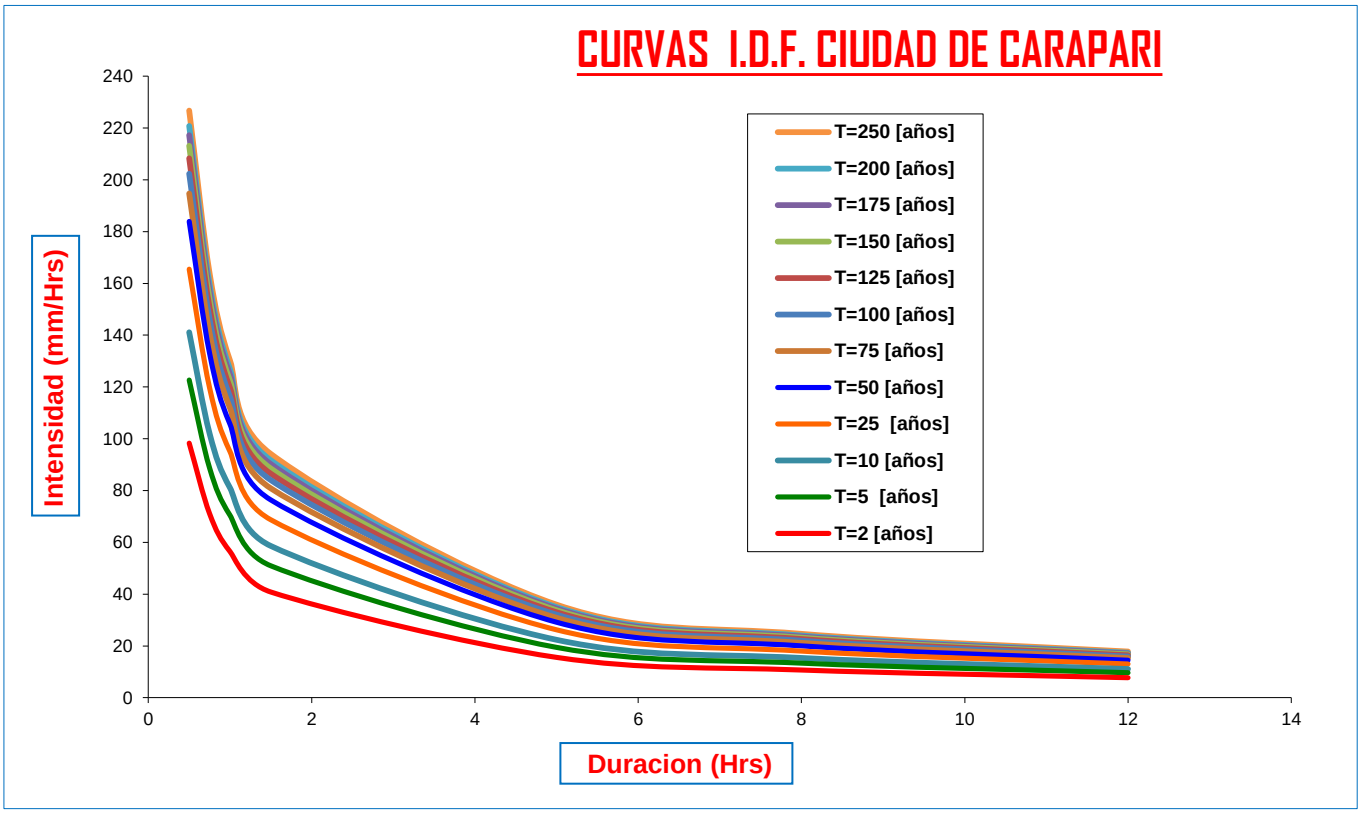
⇒ K_d = 0.77

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	49.15	53.30	56.46	61.23	77.90	85.57	92.80
5	61.33	66.52	70.45	76.41	97.21	106.79	115.81
10	70.55	76.51	81.04	87.89	111.82	122.84	133.22
25	82.74	89.73	95.04	103.07	131.13	144.05	156.22
50	91.96	99.72	105.63	114.55	145.74	160.10	173.63
75	97.35	105.57	111.82	121.27	154.29	169.49	183.81
100	101.17	109.72	116.22	126.03	160.35	176.15	191.03
125	104.14	112.94	119.63	129.73	165.05	181.32	196.64
150	106.57	115.57	122.41	132.75	168.89	185.54	201.21
175	108.62	117.79	124.77	135.31	172.14	189.11	205.08
200	110.39	119.72	126.81	137.52	174.96	192.20	208.44
250	113.36	122.93	130.21	141.21	179.66	197.37	214.04

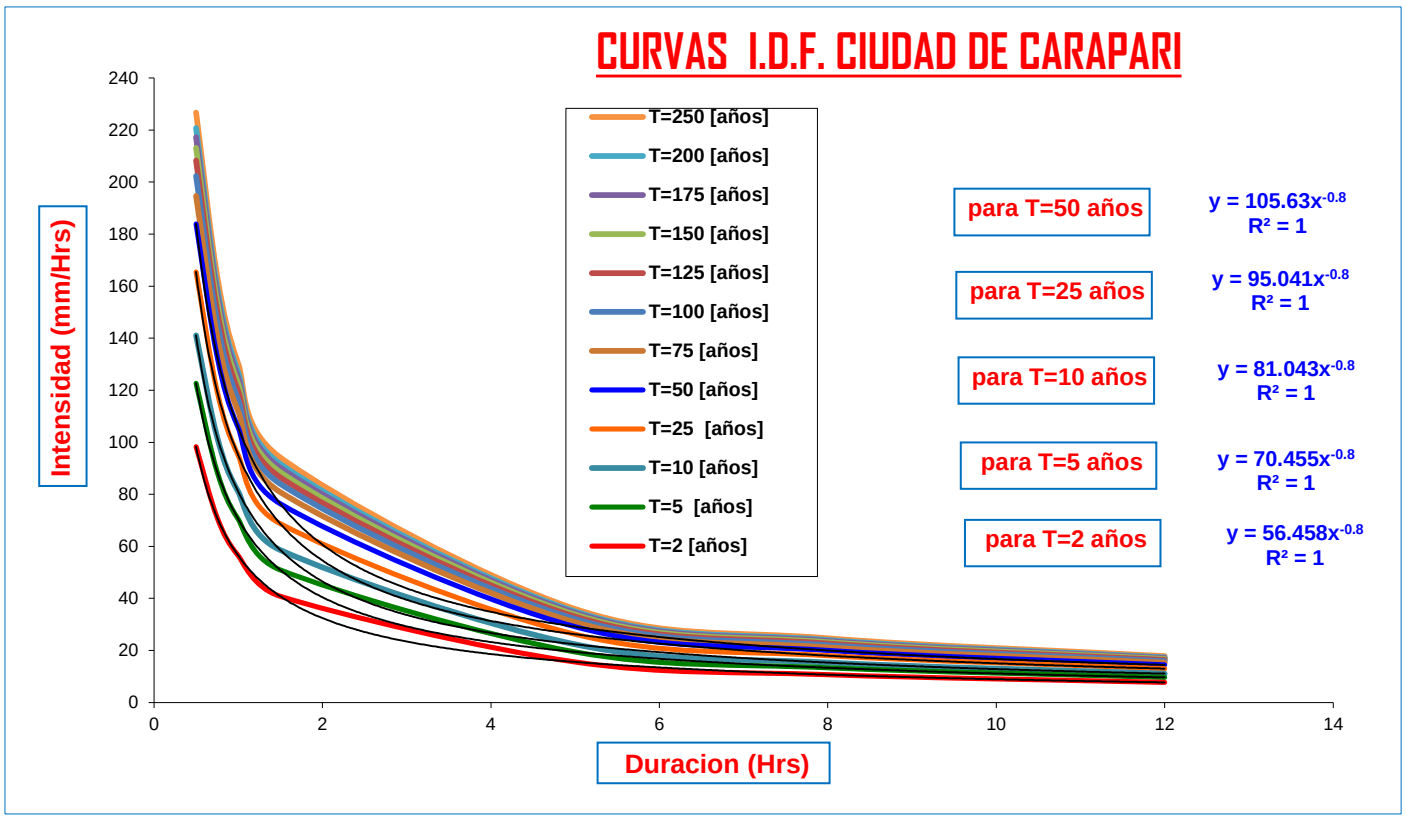


Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	98.30	71.07	56.46	40.82	15.58	10.70	7.73
5	122.67	88.69	70.45	50.94	19.44	13.35	9.65
10	141.10	102.02	81.04	58.59	22.36	15.35	11.10
25	165.48	119.64	95.04	68.71	26.23	18.01	13.02
50	183.91	132.96	105.63	76.37	29.15	20.01	14.47
75	194.69	140.76	111.82	80.85	30.86	21.19	15.32
100	202.35	146.29	116.22	84.02	32.07	22.02	15.92
125	208.28	150.58	119.63	86.49	33.01	22.66	16.39
150	213.13	154.09	122.41	88.50	33.78	23.19	16.77
175	217.23	157.05	124.77	90.20	34.43	23.64	17.09
200	220.78	159.62	126.81	91.68	34.99	24.03	17.37
250	226.72	163.91	130.21	94.14	35.93	24.67	17.84



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las lluvias maximas anuales:

Año	Estaciones para la Ciudad de El Puente			
	El Puente	Tomayapo	Paicho Centro	Tojo
1		33		
2		18.3		
3		24.5		
4		46.5		
5		32.5		
6		20		
7		20		
8	50.1	10		30.1
9	19.5	24		26.2
10	20	34		30.1
11	31	26		26.4
12	18.2	24		41.9
13	33.3	47		45.1
14	27.6	21		21.1
15	63	21		26.7
16	26	31.1		21.3
17	25	26.4		35.8
18	26	39		23.5
19	28	46		23.4
20	18	27		19.8
21	21	20.5		21.3
22	34	18.5		12.8
23	46	40		20.6
24	27.5	62.5		23.2
25	22.3	32.5	40.2	35.7
26	57.6	24	35.3	27.5

Calculos de las Medidas de Distribucion:

Media =	31.27	29.59	37.75	26.97
Desviacion =	13.36	11.64	3.46	8.02
Varianza =	178.60	135.46	12.01	64.29
N° de Datos =	19	26	2	19

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \bar{x} - 0.45\,S$$

Moda =	25.25	24.35	36.19	23.37

$$K = \frac{S}{0.557 * E}$$

Caracteristica	0.95	0.86	0.17	0.62

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° =	479.84	633.13	72.38	443.95
K*N° =	18.05	22.31	0.34	11.71

Moda Ponderada:

$$E_d = \frac{\sum E_i * n_i}{\sum n_i} =$$

24.686

Caracteristica Ponderada:

$$Kd = \frac{\sum K_i * n_i}{\sum n_i} =$$

0.794

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- Ed = Moda Ponderada
- Kd = Caracteristica Ponderada
- T = Periodo de Retorno
- hdt = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	30.59
5	38.39
10	44.29
25	52.09
50	57.99
75	61.44
100	63.89
125	65.79
150	67.34
175	68.66
200	69.79
250	71.69

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota:

Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Donde:

- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.2
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

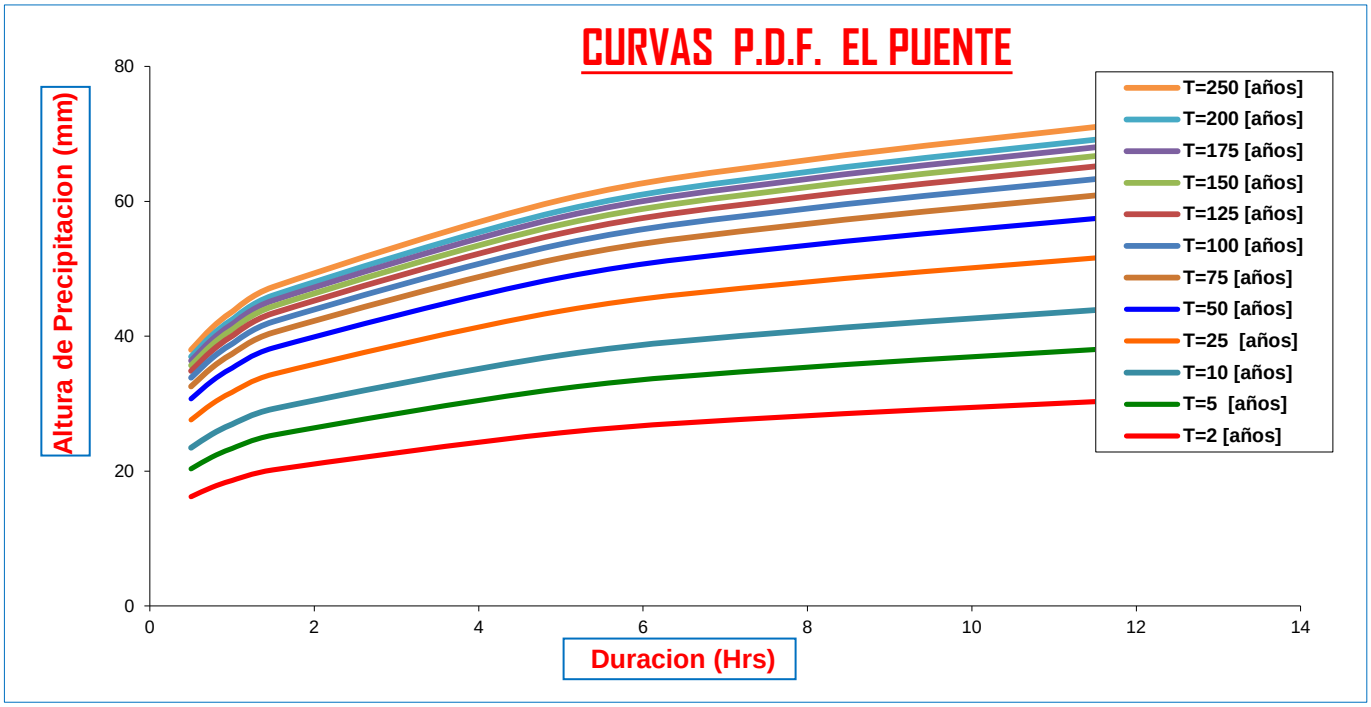
Para	A_c >	20	km^2	⇒	α =	12
Para	A_c <	20	km^2	⇒	α =	2

→ Aplicando la Formula tenemos las lluvias Maxima Horarias:

⇒ β = 0.2 ⇒ α = 12 Valor Adoptado

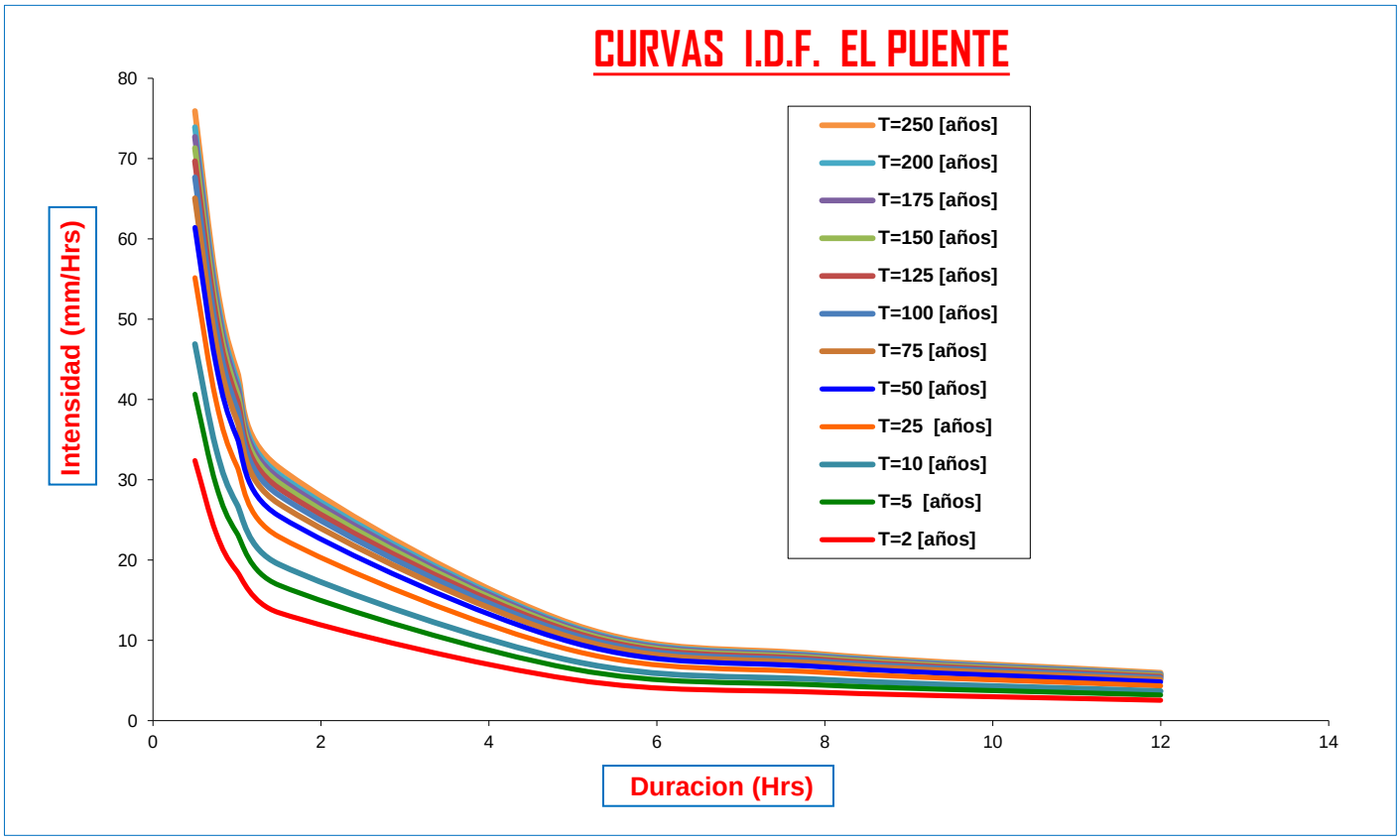
⇒ E_d = 24.69 ⇒ K_d = 0.79

Periodo de Retorno	Duracion de lluvia en (mm)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	16.20	17.57	18.61	20.18	25.67	28.20	30.59
5	20.33	22.05	23.35	25.33	32.22	35.40	38.39
10	23.46	25.44	26.94	29.22	37.18	40.84	44.29
25	27.59	29.92	31.69	34.37	43.72	48.03	52.09
50	30.71	33.31	35.28	38.26	48.68	53.47	57.99
75	32.54	35.29	37.38	40.54	51.57	56.66	61.44
100	33.84	36.70	38.87	42.15	53.63	58.92	63.89
125	34.84	37.79	40.03	43.41	55.22	60.67	65.79
150	35.67	38.68	40.97	44.43	56.53	62.10	67.34
175	36.36	39.43	41.77	45.30	57.63	63.31	68.66
200	36.96	40.09	42.46	46.05	58.58	64.36	69.79
250	37.97	41.18	43.62	47.30	60.18	66.11	71.69

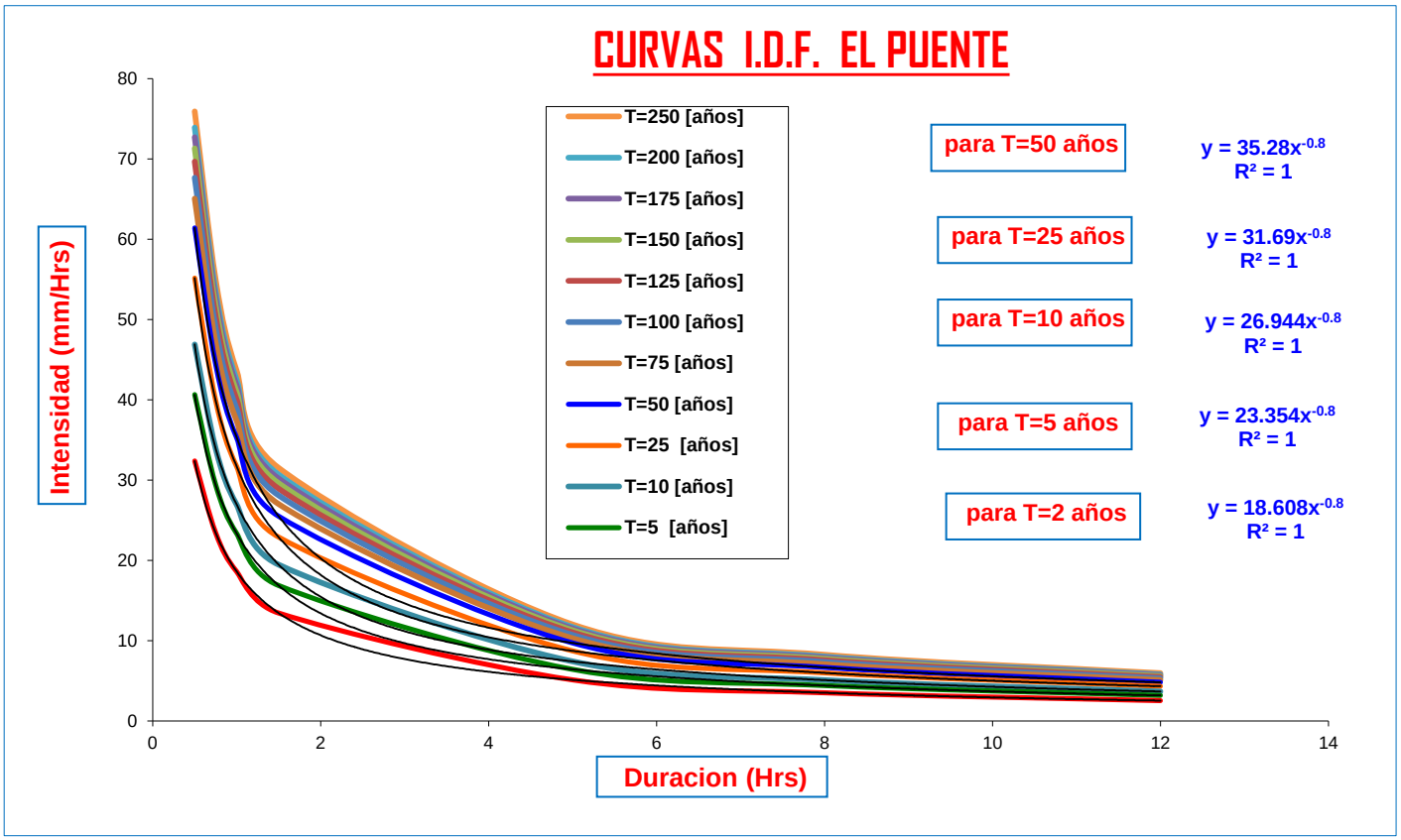


Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	32.40	23.42	18.61	13.45	5.13	3.53	2.55
5	40.66	29.40	23.35	16.88	6.44	4.42	3.20
10	46.91	33.92	26.94	19.48	7.44	5.10	3.69
25	55.18	39.89	31.69	22.91	8.74	6.00	4.34
50	61.43	44.41	35.28	25.51	9.74	6.68	4.83
75	65.08	47.05	37.38	27.03	10.31	7.08	5.12
100	67.68	48.93	38.87	28.10	10.73	7.36	5.32
125	69.69	50.38	40.03	28.94	11.04	7.58	5.48
150	71.33	51.57	40.97	29.62	11.31	7.76	5.61
175	72.72	52.58	41.77	30.20	11.53	7.91	5.72
200	73.93	53.45	42.46	30.70	11.72	8.04	5.82
250	75.94	54.90	43.62	31.53	12.04	8.26	5.97



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las lluvias maximas anuales:

Año	Estaciones para la Ciudad de Entre Rios			
	El Pajonal	Narvaez	Berety	San Josecito
1		83		
2		90.1		
3		73.2		
4		85.4		
5		60		
6		90.5		
7		98.5		
8		103.5		
9		66.3		
10	90	86.7		
11	100	63		
12	67.2	99		
13	107.2	60		90
14	142.9	110.8		89
15	104.5	114		72.1
16	95.2	56		73.4
17	74.1	68		120.3
18	81.5	81.4		49.2
19	103	80		35.8
20	93	50		92.6
21	76	75.7	70.5	64.5
22	85.1	52.5	70.4	211.4
23	74.1	64.5	72.7	63.5
24	88.6	100.1	88.3	66.9
25	34.8	84.4	20	60.5
26	58.1	62	54	122.5
27	94	80	42.3	73.5
28	103.2	80	40	59
29	51	82	56.3	86.6
30	93.3	86.6	43	120.4
31	55.9	75	72.4	70.8

Calculos de las Medidas de Distribucion:

Media =	85.12	79.43	57.26	85.37
Desviacion =	23.25	16.76	19.76	38.59
Varianza =	540.74	280.83	390.40	1489.15
N° de Datos =	22	31	11	19

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \bar{x} - 0.45\,S$$

Moda =	74.66	71.88	48.37	68.00

$$K = \frac{S}{0.557 * E}$$

Caracteristica	0.56	0.42	0.73	1.02

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° =	1642.49	2228.42	532.10	1292.06
K*N° =	12.30	12.97	8.07	19.36

Moda Ponderada: $E_d = \frac{\sum E_i * n_i}{\sum n_i} =$ 68.615

Caracteristica Ponderada: $Kd = \frac{\sum K_i * n_i}{\sum n_i} =$ 0.635

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- Ed = Moda Ponderada
- Kd = Caracteristica Ponderada
- T = Periodo de Retorno
- hdt = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	81.73
5	99.07
10	112.18
25	129.52
50	142.63
75	150.31
100	155.75
125	159.97
150	163.42
175	166.34
200	168.86

250	173.09

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota:

Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Donde:

- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.2
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

Para	A_c >	20	km^2	⇒	α =	12
Para	A_c <	20	km^2	⇒	α =	2

Aplicando la Formula tenemos las lluvias Maxima Horarias:

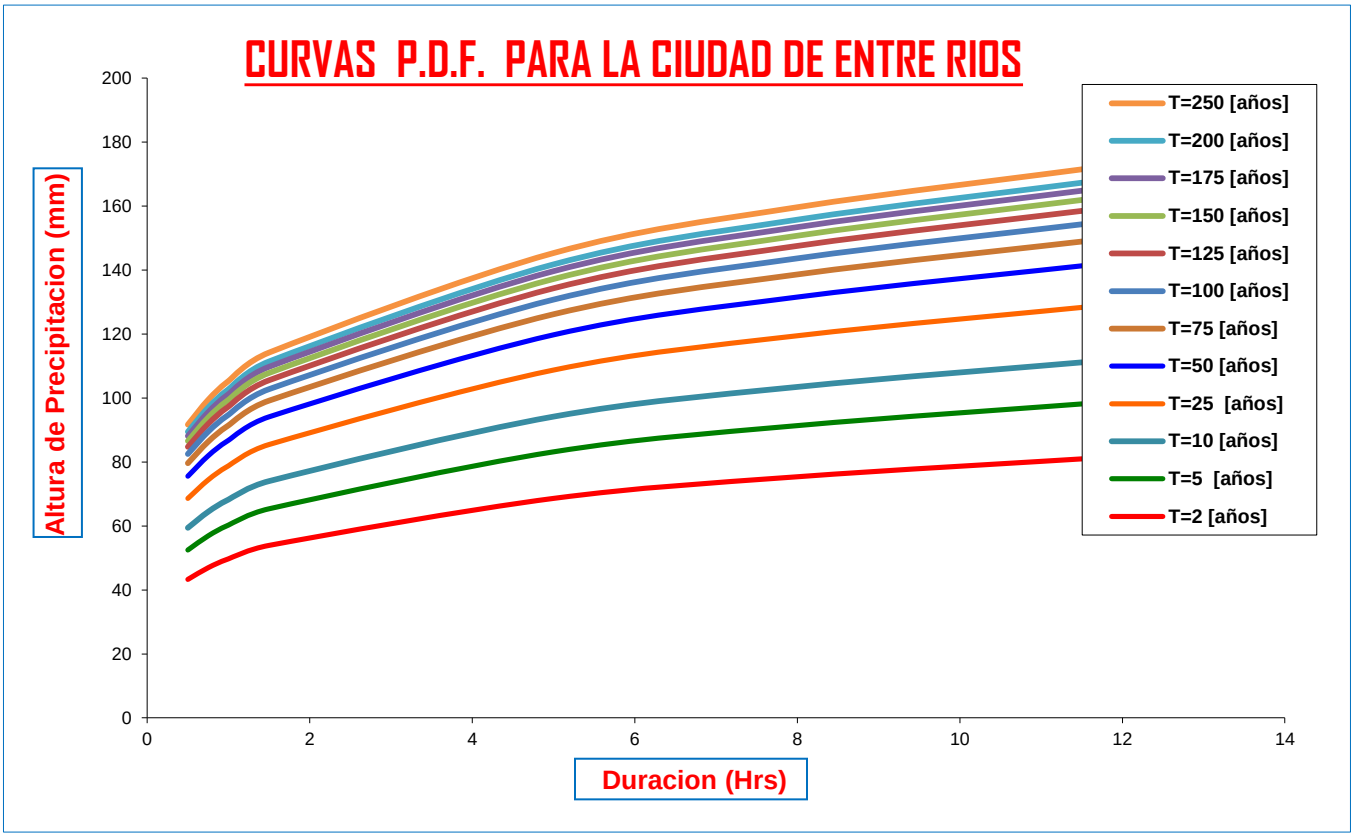
⇒ β = 0.2

⇒ E_d = 68.62

⇒ α = 12 **Valor Adoptado**

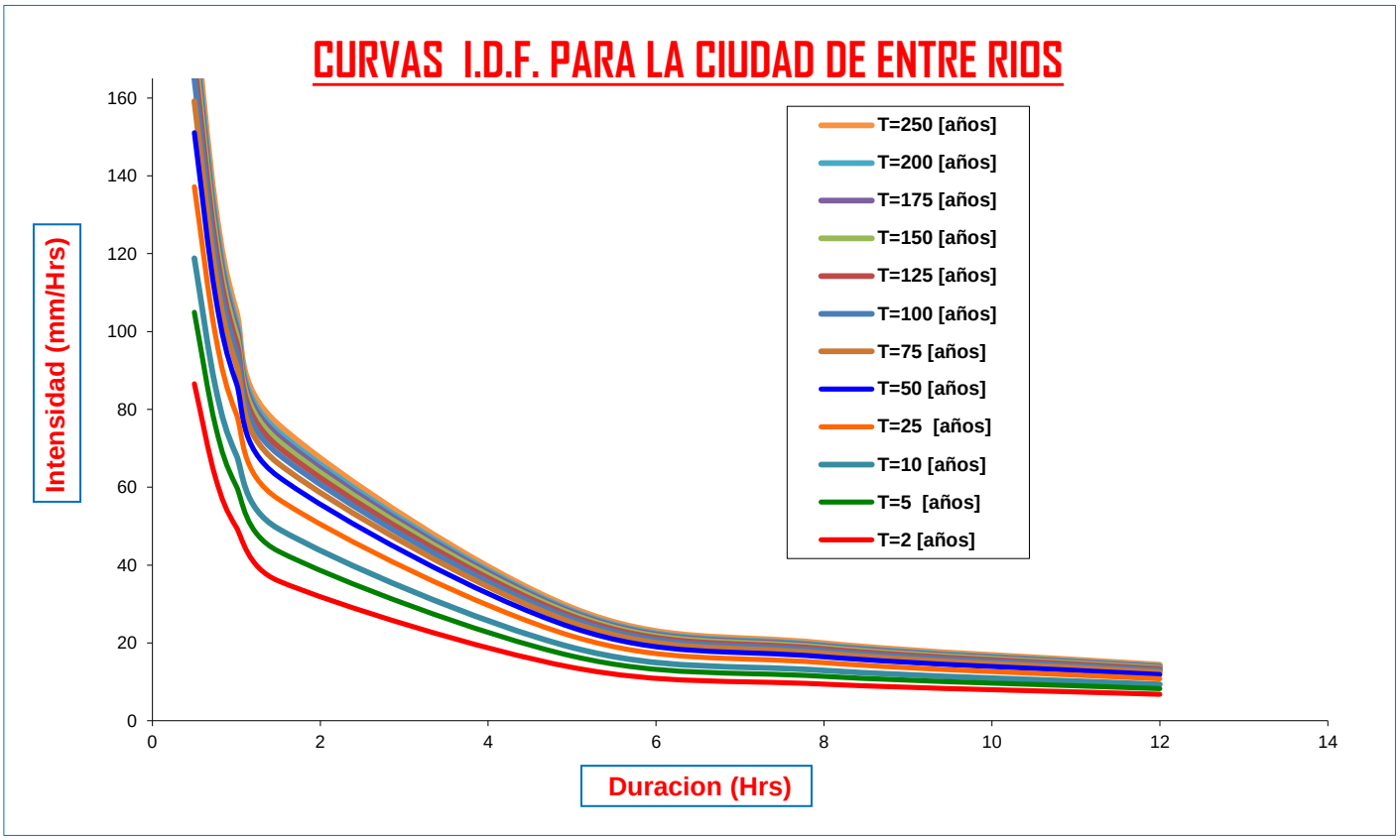
⇒ K_d = 0.63

Periodo de Retorno	Duracion de lluvia en (mm)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	43.29	46.94	49.72	53.92	68.60	75.36	81.73
5	52.47	56.90	60.27	65.36	83.15	91.35	99.07
10	59.41	64.43	68.25	74.01	94.16	103.44	112.18
25	68.59	74.39	78.79	85.45	108.72	119.43	129.52
50	75.54	81.92	86.77	94.10	119.72	131.52	142.63
75	79.60	86.33	91.44	99.16	126.16	138.60	150.31
100	82.49	89.45	94.75	102.76	130.73	143.62	155.75
125	84.72	91.88	97.32	105.54	134.28	147.51	159.97
150	86.55	93.86	99.42	107.82	137.17	150.69	163.42
175	88.09	95.54	101.19	109.74	139.62	153.38	166.34
200	89.43	96.99	102.73	111.41	141.74	155.71	168.86
250	91.67	99.41	105.30	114.19	145.28	159.60	173.09

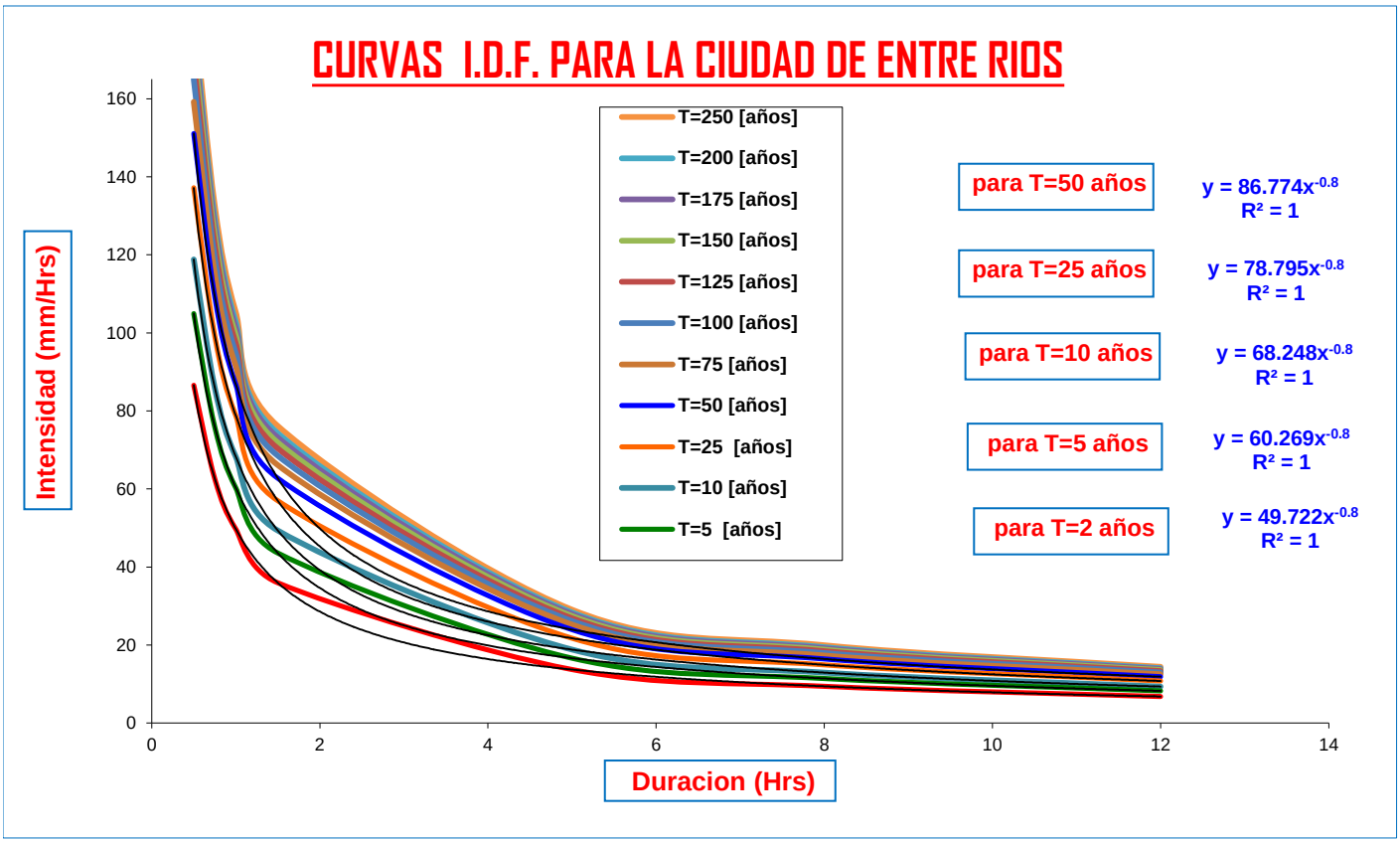


Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	86.57	62.59	49.72	35.95	13.72	9.42	6.81
5	104.93	75.87	60.27	43.57	16.63	11.42	8.26
10	118.83	85.91	68.25	49.34	18.83	12.93	9.35
25	137.19	99.19	78.79	56.97	21.74	14.93	10.79
50	151.08	109.23	86.77	62.74	23.94	16.44	11.89
75	159.21	115.10	91.44	66.11	25.23	17.32	12.53
100	164.97	119.27	94.75	68.50	26.15	17.95	12.98
125	169.45	122.51	97.32	70.36	26.86	18.44	13.33
150	173.10	125.15	99.42	71.88	27.43	18.84	13.62
175	176.19	127.38	101.19	73.16	27.92	19.17	13.86
200	178.86	129.32	102.73	74.27	28.35	19.46	14.07
250	183.34	132.55	105.30	76.13	29.06	19.95	14.42



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las Precipitaciones maximas anuales:

Año	Estaciones para la Ciudad de Iscayachi		
	Cumbre Sama	Campanario	El Molino
1		25	
2	49.5	19.8	20.6
3	21.8	28.6	18.4
4	50.5	19.6	33.5
5	49.7	31.2	38.4
6	64.9	28.1	40.9
7	40.8	30	35.4
8	62.3	27.1	45.6
9	56.4	34.1	35.8
10	23.6	19.5	45.8
11	64.2	23.4	35.4
12	57	33.7	25.3
13	62.3	33.2	23.2
14	71	29.6	35.1
15	57	25	59.3
16	38.5	37.7	35.8
17	60.5	20.8	38.6
18	56	26.5	46.3
19	42	26.2	42.6

Calculos de las Medidas de Distribucion:

Media =	51.56	27.32	36.44
Desviacion =	13.68	5.31	10.14
Varianza =	187.21	28.14	102.75
N° de Datos =	18	19	18

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \bar{x} - 0.45\,S$$

Moda =	45.40	24.93	31.88

$$K = \frac{S}{0.557 * E}$$

Caracteristica	0.54	0.38	0.57

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° =	817.17	473.74	573.89
K*N° =	9.74	7.26	10.27

Moda Ponderada:

$$E_d = \frac{\sum E_i * n_i}{\sum n_i} = 33.906$$

Caracteristica Ponderada:

$$Kd = \frac{\sum K_i * n_i}{\sum n_i} = 0.496$$

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- Ed = Moda Ponderada
- Kd = Caracteristica Ponderada
- T = Periodo de Retorno
- hdt = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	38.97
5	45.66
10	50.72
25	57.41
50	62.47
75	65.43
100	67.53
125	69.16
150	70.49
175	71.62
200	72.59
250	74.22

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota:

Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Ed = Moda Ponderada

Donde:

- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.02
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

Para $A_c >$ 20 km^2 ⇒ α = 12

Para $A_c <$ 20 km^2 ⇒ α = 2

→ Aplicando la Formula tenemos las lluvias Maxima Horarias:

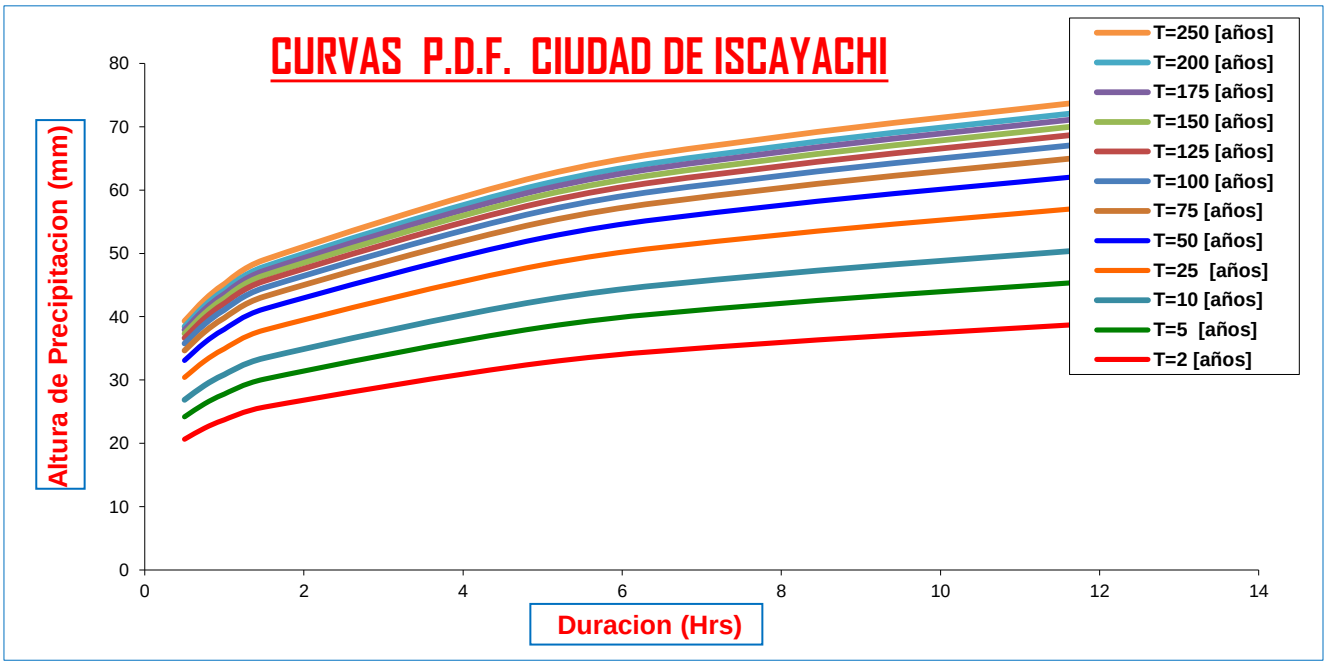
⇒ β = 0.2

⇒ E_d = 33.91

⇒ α = 12 **Valor Adoptado**

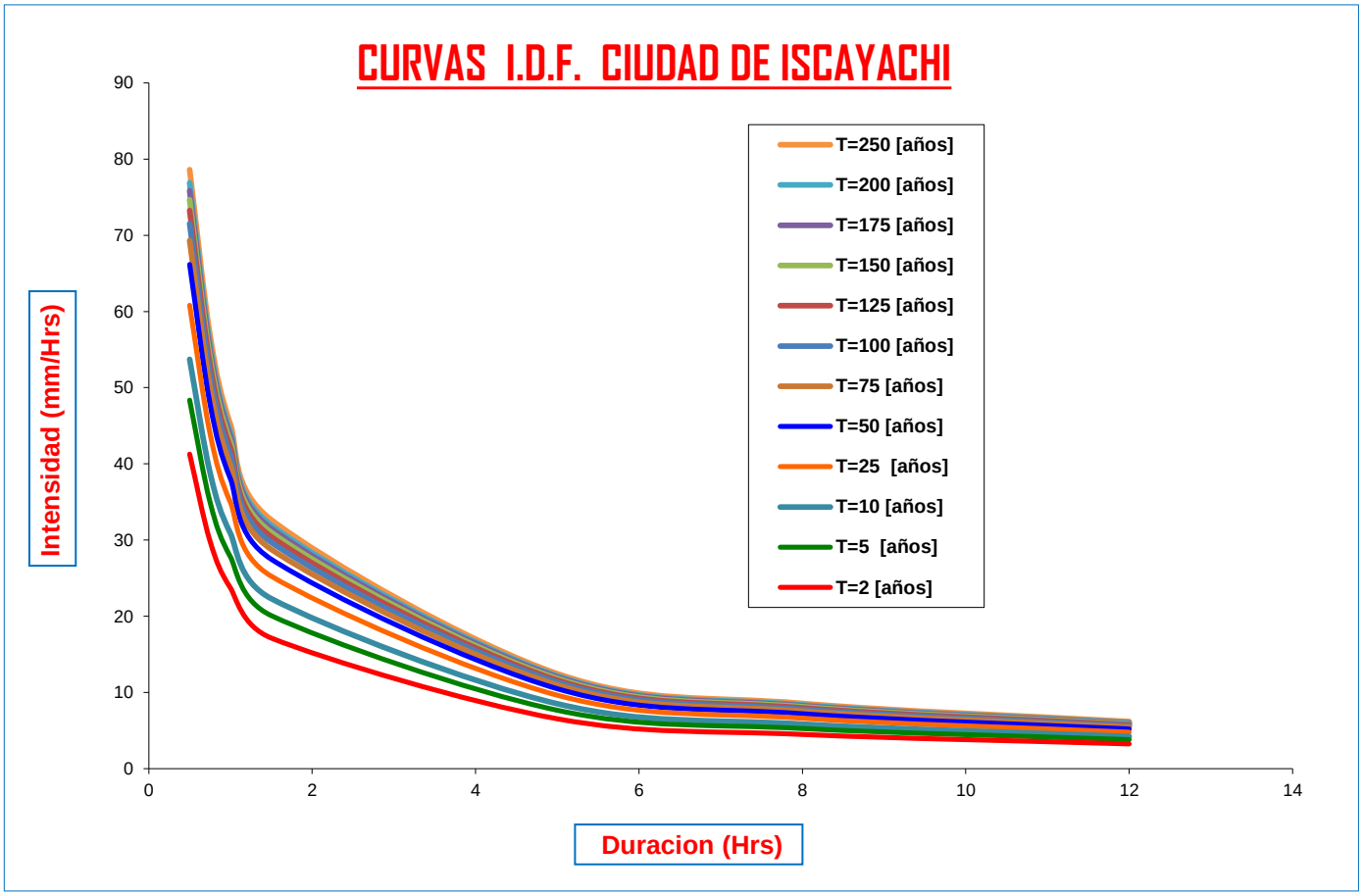
⇒ K_d = 0.50

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	20.64	22.38	23.71	25.71	32.71	35.93	38.97
5	24.18	26.22	27.78	30.12	38.32	42.10	45.66
10	26.86	29.13	30.85	33.46	42.57	46.77	50.72
25	30.40	32.97	34.92	37.88	48.19	52.94	57.41
50	33.08	35.88	38.00	41.21	52.43	57.60	62.47
75	34.65	37.58	39.80	43.17	54.92	60.33	65.43
100	35.76	38.79	41.08	44.55	56.68	62.27	67.53
125	36.63	39.72	42.07	45.63	58.05	63.77	69.16
150	37.33	40.49	42.88	46.51	59.17	65.00	70.49
175	37.93	41.13	43.57	47.25	60.11	66.04	71.62
200	38.44	41.69	44.16	47.89	60.93	66.94	72.59
250	39.31	42.63	45.15	48.97	62.30	68.44	74.22

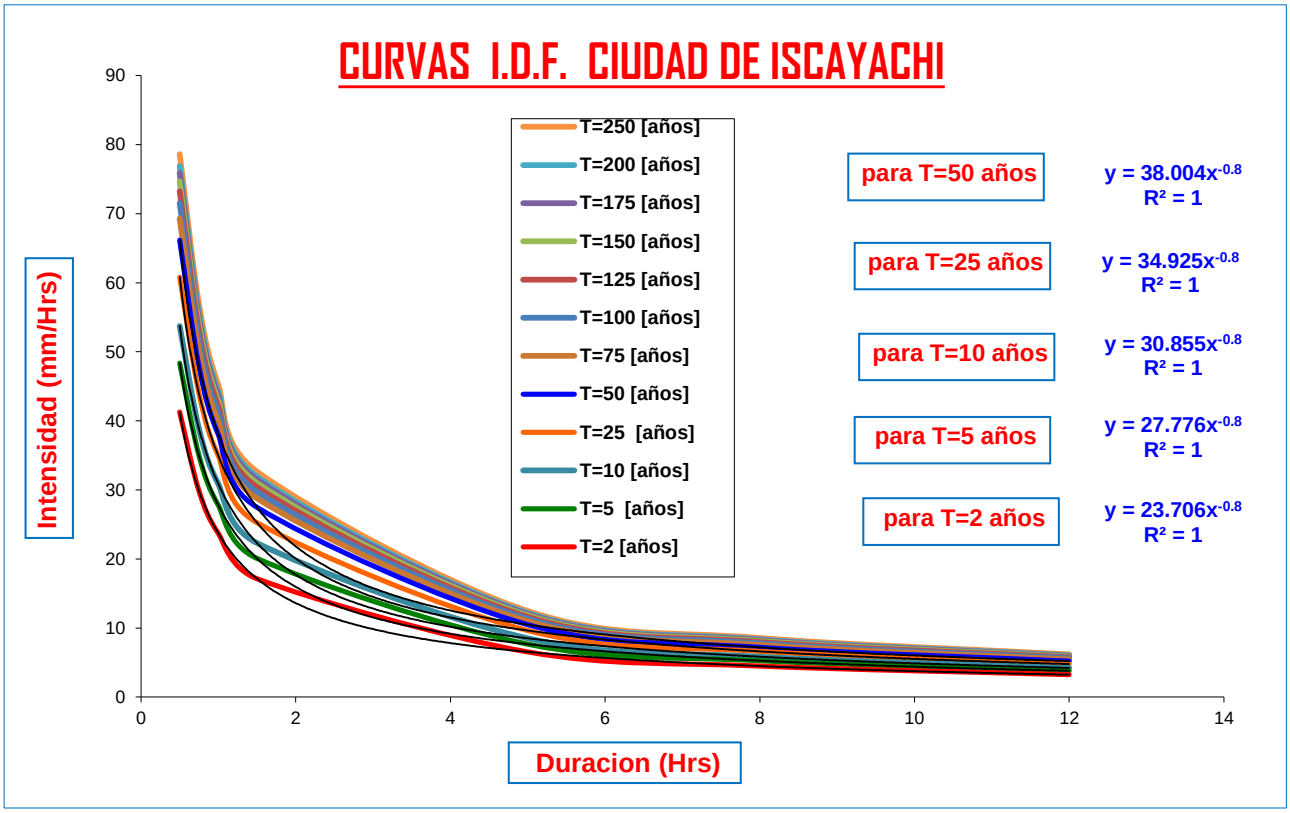


Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	41.27	29.84	23.71	17.14	6.54	4.49	3.25
5	48.36	34.96	27.78	20.08	7.66	5.26	3.80
10	53.72	38.84	30.85	22.31	8.51	5.85	4.23
25	60.81	43.96	34.92	25.25	9.64	6.62	4.78
50	66.17	47.84	38.00	27.48	10.49	7.20	5.21
75	69.30	50.11	39.80	28.78	10.98	7.54	5.45
100	71.53	51.71	41.08	29.70	11.34	7.78	5.63
125	73.25	52.96	42.07	30.42	11.61	7.97	5.76
150	74.66	53.98	42.88	31.00	11.83	8.12	5.87
175	75.86	54.84	43.57	31.50	12.02	8.25	5.97
200	76.89	55.59	44.16	31.93	12.19	8.37	6.05
250	78.62	56.84	45.15	32.64	12.46	8.55	6.19



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las lluvias maximas anuales:

Año	Estaciones para la Ciudad de Padcaya				
	Padcaya	Colon Sud	Cenavit	La Angostura	Canchas Mayu
1	43.5				
2	48.7				
3	35.5				
4	128				
5	56				
6	42				
7	25		60.1		
8	38.2		43.6		58.2
9	32.9		37.4		45.3
10	30		51.5		50
11	27	59.5	45		96.5
12	29	33.7	36	38	55.4
13	29	45.2	56.5	31.2	95.3
14	49	32.5	36.4	23.3	60
15	43	14.5	43.5	56	53.8
16	61	35.8	92	58.3	60.7
17	43	40.5	45.3	60.4	60.7
18	23.5	54.2	33.5	29.3	62.3
19	19.5	80.8	116.5	40.3	65.6
20	54.5	30.5	33.5	45	45.2
21	40	38.4	39.8	41	90.8
22	193	30.4	40.5	75	70
23	36	47.3	44	49	87.7
24	91	43.5	27	57	88.5

Calculos de las Medidas de Distribucion:

Media =	50.76	41.91	49.01	46.45	67.41
Desviacion =	38.22	15.78	22.08	14.61	17.51
Varianza =	1460.46	248.99	487.57	213.56	306.76
N° de Datos =	24	14	18	13	17

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \overline{x} - 0.45\,S$$

Moda =	33.57	34.81	39.07	39.87	59.53

$$K = \frac{S}{0.557 * E}$$

Caracteristica	2.04	0.81	1.01	0.66	0.53

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° =	805.57	487.39	703.24	518.31	1012.01
K*N° =	49.06	11.39	18.26	8.55	8.98

Moda Ponderada: $$E_d = \frac{\sum E_i * n_i}{\sum n_i} =$$ 41.006

Caracteristica Ponderada: $$Kd = \frac{\sum K_i * n_i}{\sum n_i} =$$ 1.119

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- Ed = Moda Ponderada
- Kd = Caracteristica Ponderada
- T = Periodo de Retorno
- hdt = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	54.82
5	73.08
10	86.90
25	105.16
50	118.98
75	127.06
100	132.79
125	137.24
150	140.87
175	143.95
200	146.61
250	151.05

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota: Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Donde:

- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.2
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

Para A_c > 20 km^2 ⇒ α = 12

Para A_c < 20 km^2 ⇒ α = 2

→ Aplicando la Formula tenemos las lluvias Maxima Horarias:

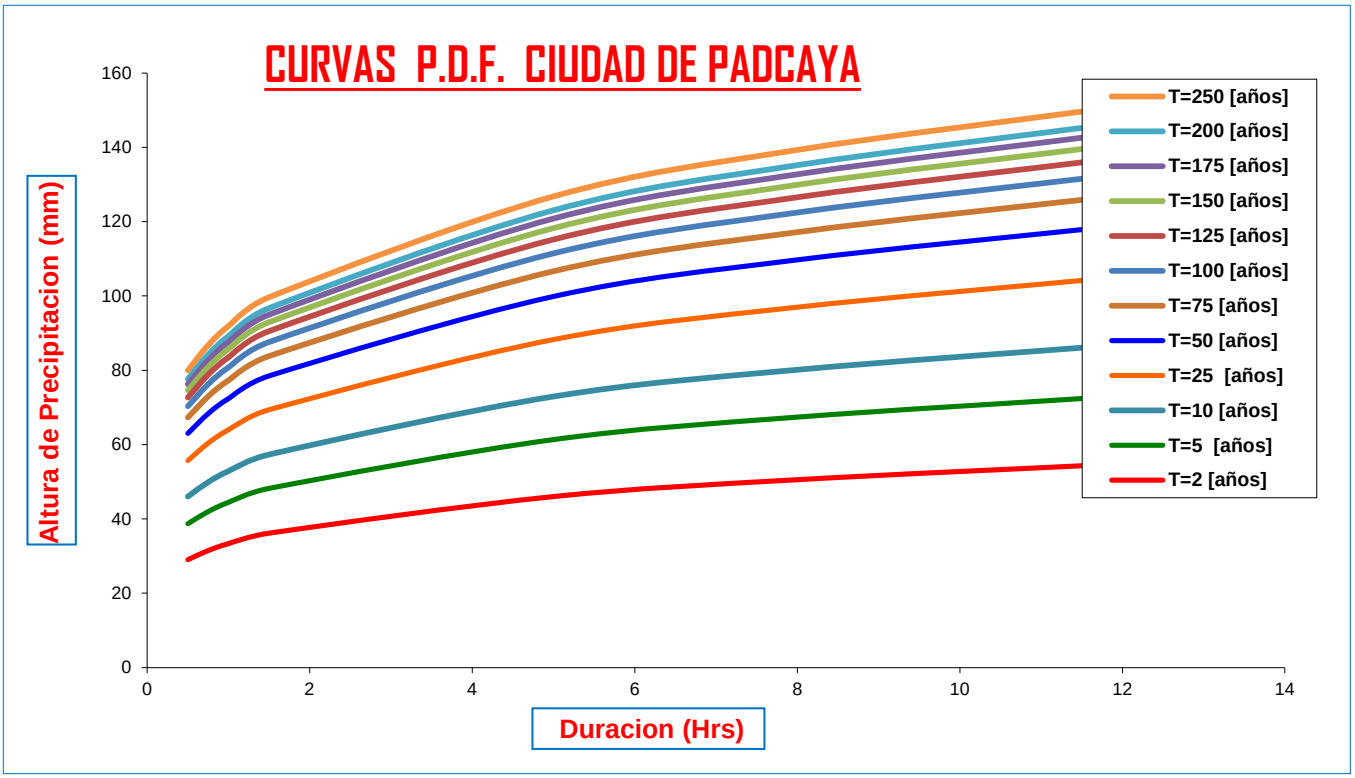
⇒ β = 0.2

⇒ E_d = 41.01

⇒ α = 12 **Valor Adoptado**

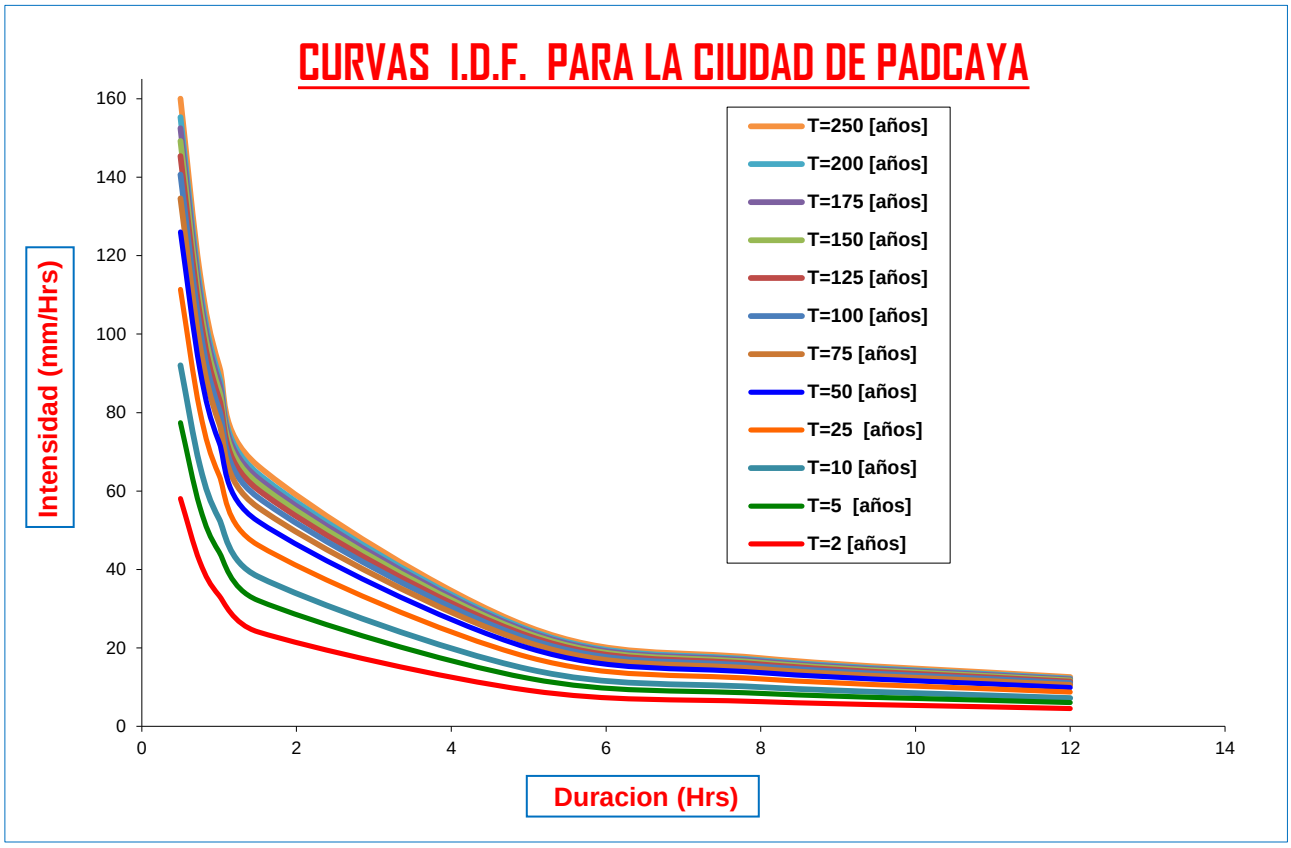
⇒ K_d = 1.12

Periodo de Retorno	Duracion de lluvia en (mm)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	29.03	31.49	33.35	36.17	46.02	50.55	54.82
5	38.71	41.98	44.46	48.22	61.35	67.39	73.08
10	46.02	49.91	52.87	57.33	72.94	80.13	86.90
25	55.69	60.40	63.98	69.38	88.27	96.97	105.16
50	63.01	68.33	72.38	78.50	99.87	109.71	118.98
75	67.29	72.98	77.30	83.83	106.65	117.16	127.06
100	70.33	76.27	80.79	87.61	111.46	122.45	132.79
125	72.68	78.82	83.49	90.54	115.20	126.55	137.24
150	74.61	80.91	85.70	92.94	118.25	129.90	140.87
175	76.24	82.68	87.57	94.97	120.83	132.73	143.95
200	77.65	84.20	89.19	96.72	123.06	135.19	146.61
250	80.00	86.76	91.90	99.66	126.79	139.29	151.05

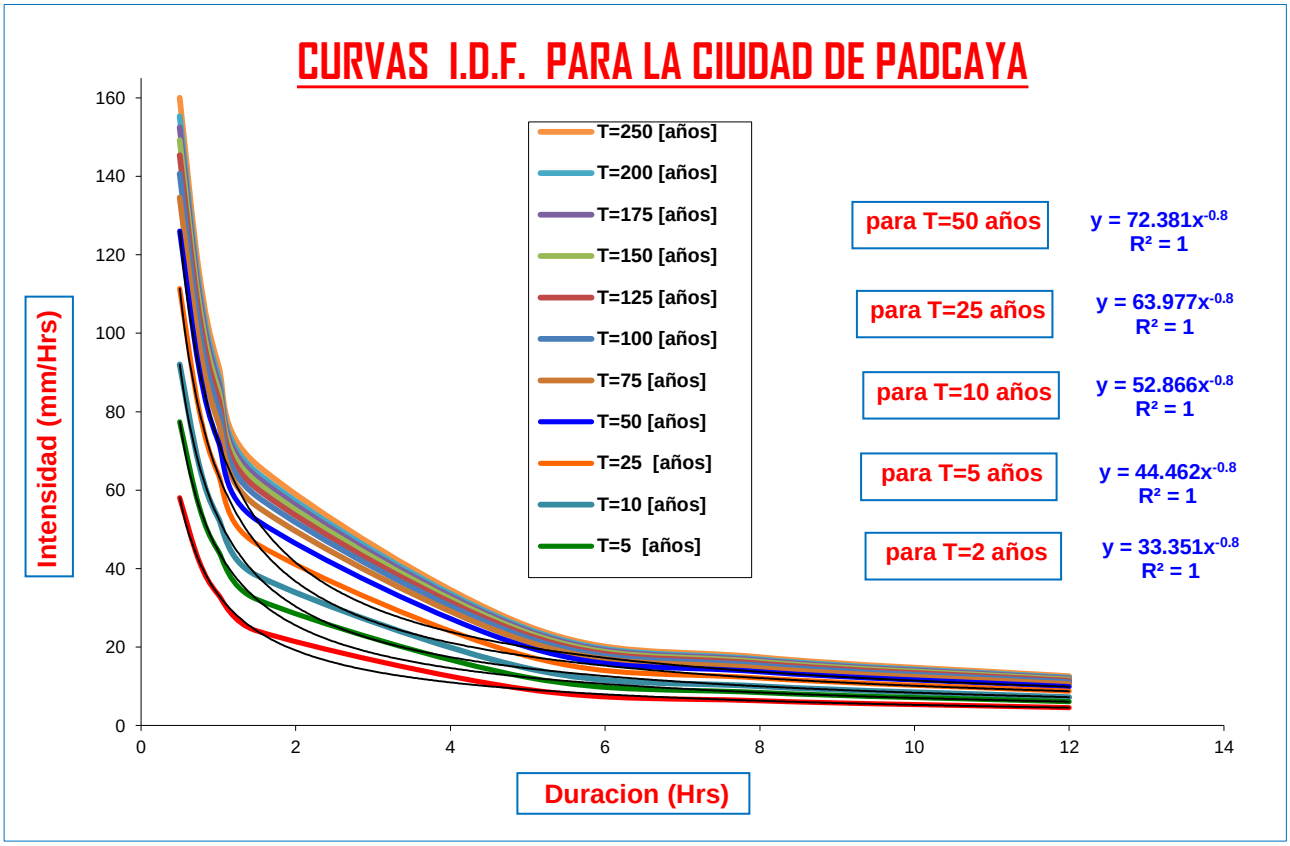


Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	58.07	41.98	33.35	24.11	9.20	6.32	4.57
5	77.41	55.97	44.46	32.14	12.27	8.42	6.09
10	92.05	66.55	52.87	38.22	14.59	10.02	7.24
25	111.39	80.53	63.98	46.25	17.65	12.12	8.76
50	126.02	91.11	72.38	52.33	19.97	13.71	9.91
75	134.58	97.30	77.30	55.88	21.33	14.65	10.59
100	140.66	101.69	80.79	58.41	22.29	15.31	11.07
125	145.37	105.10	83.49	60.36	23.04	15.82	11.44
150	149.22	107.88	85.70	61.96	23.65	16.24	11.74
175	152.47	110.23	87.57	63.31	24.17	16.59	12.00
200	155.29	112.27	89.19	64.48	24.61	16.90	12.22
250	160.00	115.68	91.90	66.44	25.36	17.41	12.59



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las lluvias maximas anuales:

Año	Estaciones para la Ciudad de Tarija					
	El Tejar	Aeropuerto	Gamoneda	San Jacinto Sud	Ciudad Tarija	Tomatitas
1		125				
2		55.3				
3		57.2				
4		56				
5		51				
6		60.1				
7		70				
8		37				
9		51				
10		52				
11		40				
12		40.3				
13		106				
14		56				
15		57				
16		83.3				
17		67.5				
18		38				
19	68.5	58.9				
20	34.5	88.3				
21	71	36				
22	46	59		28		
23	34.3	49		59		
24	48.6	31.8		35		
25	38.3	39.7		29.5		
26	32	64.4		49		
27	49.5	41		38		
28	58	41.2		48.5		
29	55.5	84.7		38.5		
30	41	40.5		65		
31	91.5	97.8	26	43		
32	41.7	40.1	55.5	49.1		
33	80	45.2	37.4	68.2		
34	56	74	14	45		
35	66.5	47	55	50.7	49	
36	105.7	68.1	41.2	62	94	
37	70.6	31	41.2	40	49	
38	47.8	50.1	53.5	53.8	88	

39	33	35.6	56.1	24.4	42	
40	84	52	45	82	30	
41	36.5	38.4	62.5	50.8	55	
42	67	74.7	50.6	36.5	47	
43	57	78	55.6	110.5	58	
44	47.5	37	66.5	80.5	54	
45	80	82	74.5	80.3	46	
46	81.3	60	54.7	80.5	64	
47	50	48.8	54	100	80	64
48	90	54.2	25	60	80	53
49	49.6	49.5	59.7	55	93	74
50	39	48.3	109	47.4	63	64
51	43.3	34.2	93.8	48.5	58	62
52	37	49.5	49.7	55.6	92	58
53	84	75.2	49.2	58	54	47

Calculos de las Medidas de Distribucion:

Media =	57.61	56.75	53.47	55.38	62.95	60.29
Desviacion =	19.83	19.86	20.51	20.07	19.22	8.69
Varianza =	393.32	394.55	420.77	402.66	369.39	75.57
N° de Datos =	35	53	23	32	19	7

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \bar{x} - 0.45\,S$$

Moda =	48.68	47.81	44.23	46.35	54.30	56.37

$$K = \frac{S}{0.557 * E}$$

Caracteristica	0.73	0.75	0.83	0.78	0.64	0.28

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° =	1703.84	2534.16	1017.39	1483.34	1031.67	394.62
K*N° =	25.60	39.53	19.15	24.87	12.07	1.94

Moda Ponderada: $E_d = \frac{\sum E_i * n_i}{\sum n_i} =$ 48.314

Caracteristica Ponderada: $Kd = \frac{\sum K_i * n_i}{\sum n_i} =$ 0.729

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{dt} = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	58.91
5	72.92
10	83.52
25	97.53
50	108.13
75	114.33
100	118.73
125	122.14
150	124.93
175	127.29
200	129.33
250	132.74

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota: Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Donde:

- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.2
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

Para	A_c >	20	km^2	⇒	α =	12
Para	A_c <	20	km^2	⇒	α =	2

Aplicando la Formula tenemos las lluvias Maxima Horarias:

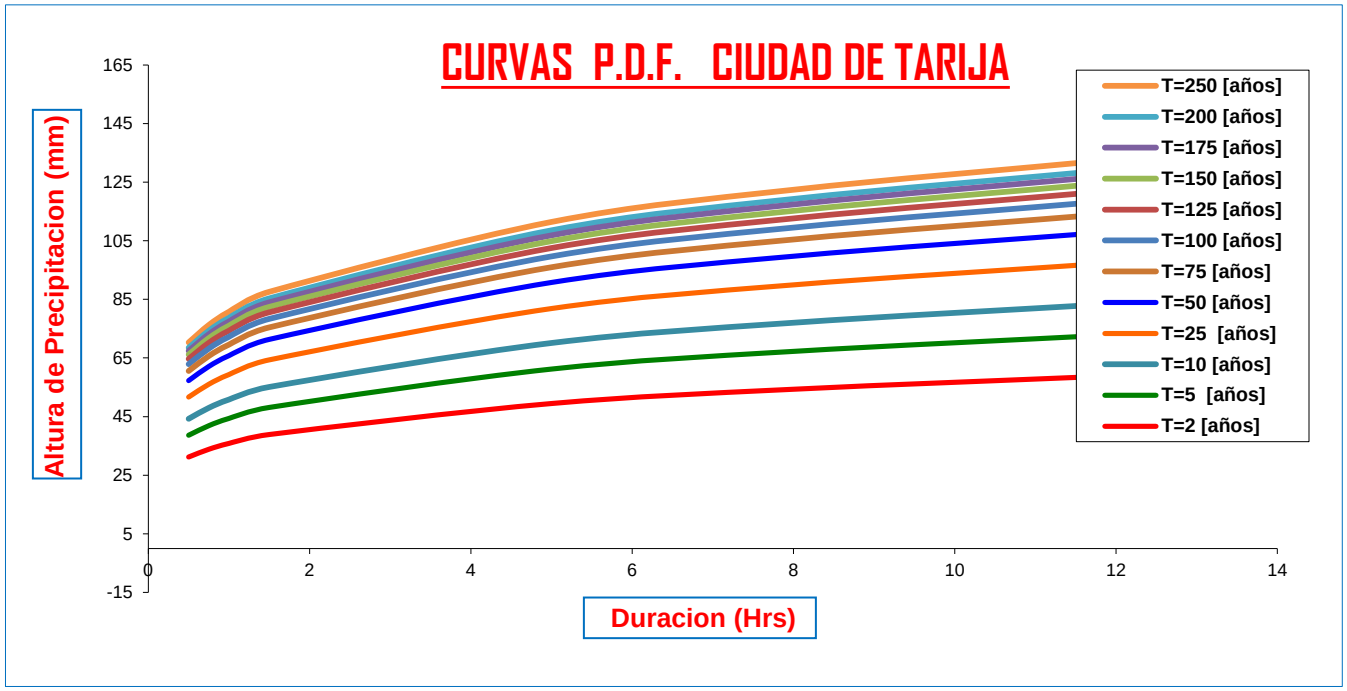
$\beta = 0.2$

$E_d = 48.31$

$\alpha = 12$ Valor Adoptado

$K_d = 0.73$

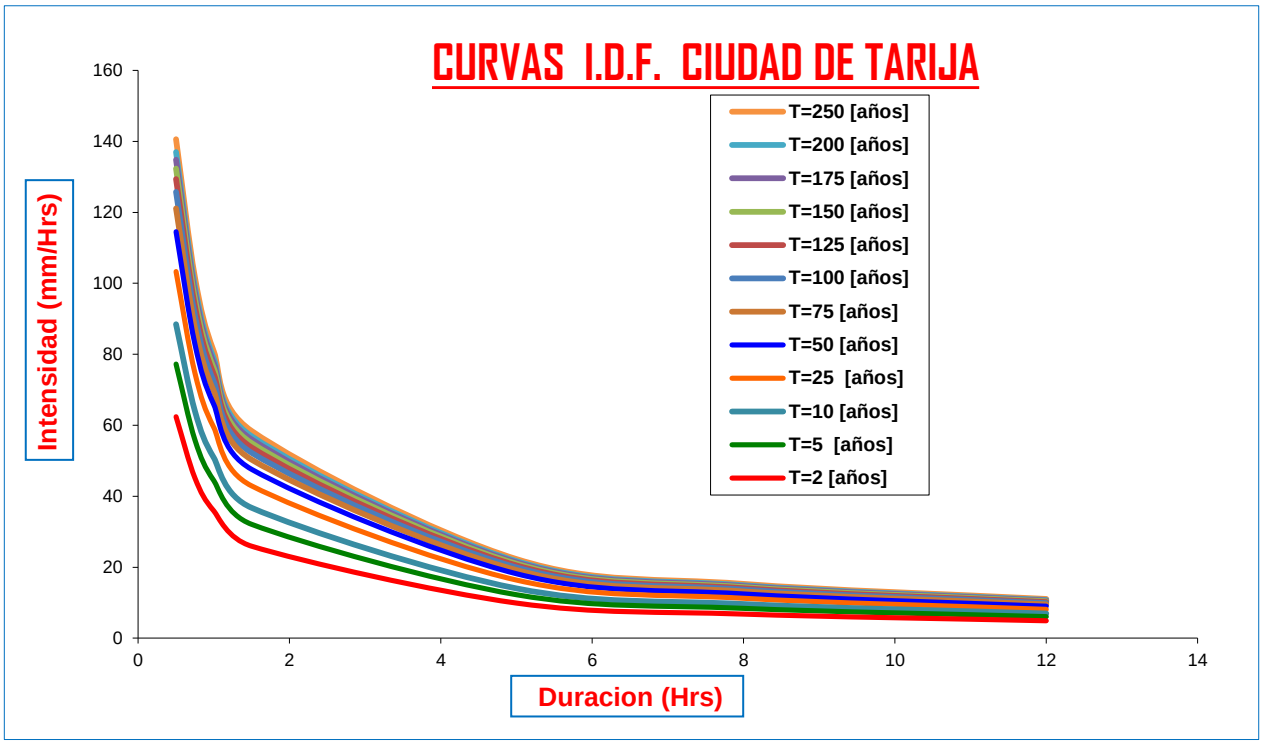
Periodo de Retorno	Duracion de lluvia en (mm)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	31.20	33.84	35.84	38.87	49.45	54.32	58.91
5	38.62	41.88	44.36	48.11	61.21	67.24	72.92
10	44.23	47.97	50.81	55.10	70.11	77.02	83.52
25	51.65	56.02	59.34	64.35	81.87	89.94	97.53
50	57.27	62.11	65.78	71.34	90.76	99.71	108.13
75	60.55	65.67	69.56	75.43	95.97	105.43	114.33
100	62.88	68.19	72.23	78.33	99.66	109.48	118.73
125	64.69	70.15	74.31	80.58	102.52	112.63	122.14
150	66.16	71.75	76.00	82.42	104.86	115.20	124.93
175	67.41	73.11	77.44	83.98	106.84	117.37	127.29
200	68.49	74.28	78.68	85.33	108.56	119.26	129.33
250	70.30	76.24	80.76	87.58	111.42	122.40	132.74



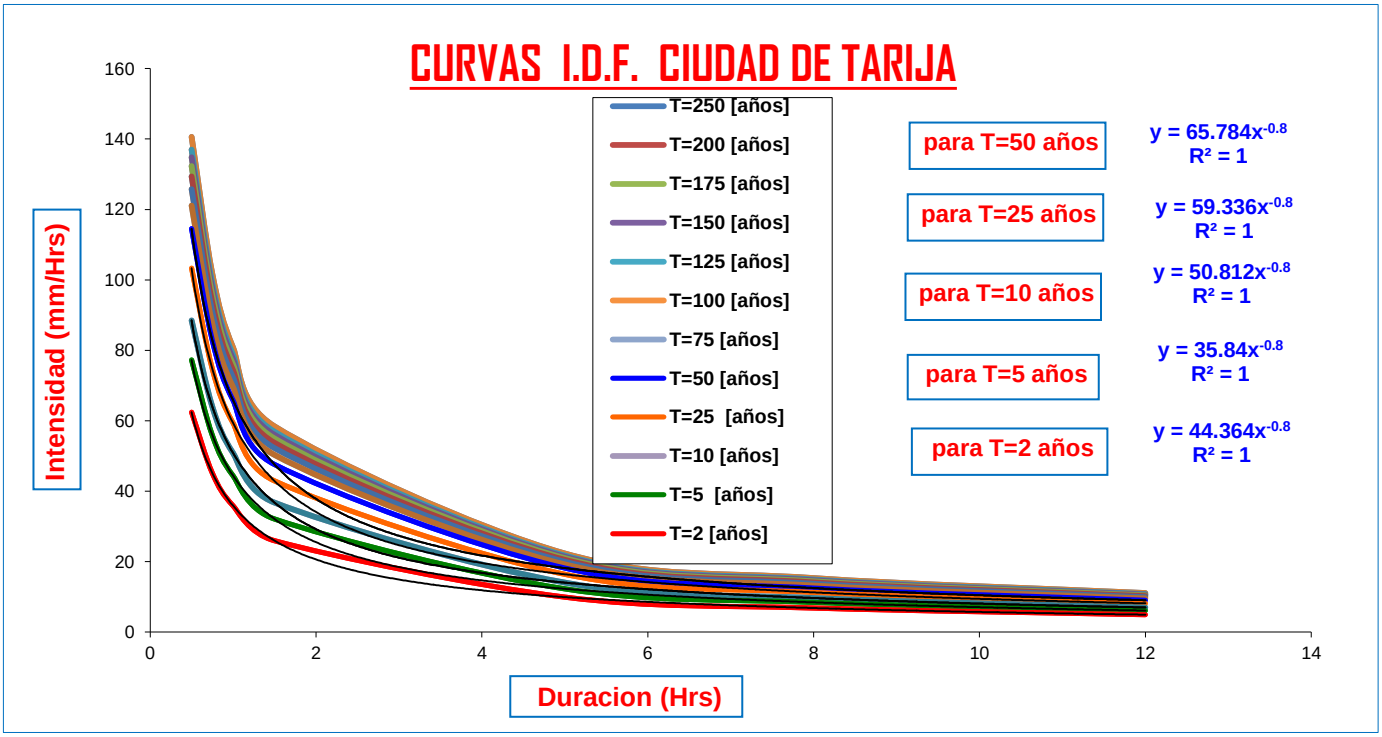
Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	62.40	45.12	35.84	25.91	9.89	6.79	4.91
5	77.24	55.84	44.36	32.07	12.24	8.41	6.08
10	88.47	63.96	50.81	36.74	14.02	9.63	6.96
25	103.31	74.69	59.34	42.90	16.37	11.24	8.13
50	114.54	82.81	65.78	47.56	18.15	12.46	9.01
75	121.10	87.56	69.56	50.29	19.19	13.18	9.53

100	125.76	90.92	72.23	52.22	19.93	13.69	9.89
125	129.38	93.54	74.31	53.72	20.50	14.08	10.18
150	132.33	95.67	76.00	54.95	20.97	14.40	10.41
175	134.83	97.48	77.44	55.99	21.37	14.67	10.61
200	136.99	99.04	78.68	56.88	21.71	14.91	10.78
250	140.60	101.65	80.76	58.38	22.28	15.30	11.06



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las lluvias maximas anuales:

Año	Estaciones para la Ciudad de Valle de la Concepcion				
	Chocloca	Juntas	Colon Norte	Calamuchita	San Nicolas
1		56.1			
2		79.5			
3		33			
4		40.4			
5		78.2			
6		40.5			
7		37.2			
8	34.3	49.1			
9	48.1	38.9			
10	40	46.5			
11	51	62.5			
12	56	56.2			
13	46.3	55			
14	30.5	32			
15	29.5	36			
16	46	29			
17	30.5	37			
18	60.2	32			
19	45.3	23			
20	34.2	32		30	
21	32	26		24.2	45
22	34.4	37		31	56
23	44.3	39		53.5	48
24	36.4	47		25.5	52
25	36.5	100		50.5	49.5
26	74.8	75		35	61
27	50.8	39		40	43
28	59	51		27.2	43.5
29	45	66		38	40
30	63	46	36	36.7	51
31	66.5	64	36	33	41
32	50	82	51	42	53.4
33	55	44.5	36	42	126
34	66	69.5	43	42	31
35	55	68.5	23	65	32.5

Calculos de las Medidas de Distribucion:

Media =	47.16	49.96	37.50	38.48	51.53
Desviacion =	12.45	18.45	9.27	10.91	22.17
Varianza =	154.97	340.22	85.90	119.06	491.67
N° de Datos =	28	35	6	16	15

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \bar{x} - 0.45\,S$$

Moda =	41.56	41.66	33.33	33.56	41.55

$$K = \frac{S}{0.557 * E}$$

Caracteristica	0.54	0.79	0.50	0.58	0.96

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° =	1163.75	1458.09	199.98	537.04	623.23
K*N° =	15.06	27.82	3.00	9.34	14.37

Moda Ponderada: $E_d = \frac{\sum E_i * n_i}{\sum n_i} =$ 39.821

Caracteristica Ponderada: $Kd = \frac{\sum K_i * n_i}{\sum n_i} =$ 0.696

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- Ed = Moda Ponderada
- Kd = Caracteristica Ponderada
- T = Periodo de Retorno
- hdt = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	48.16
5	59.19
10	67.53
25	78.56
50	86.90
75	91.78
100	95.24

125	97.92
150	100.12
175	101.97
200	103.58
250	106.26

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota: Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Donde:

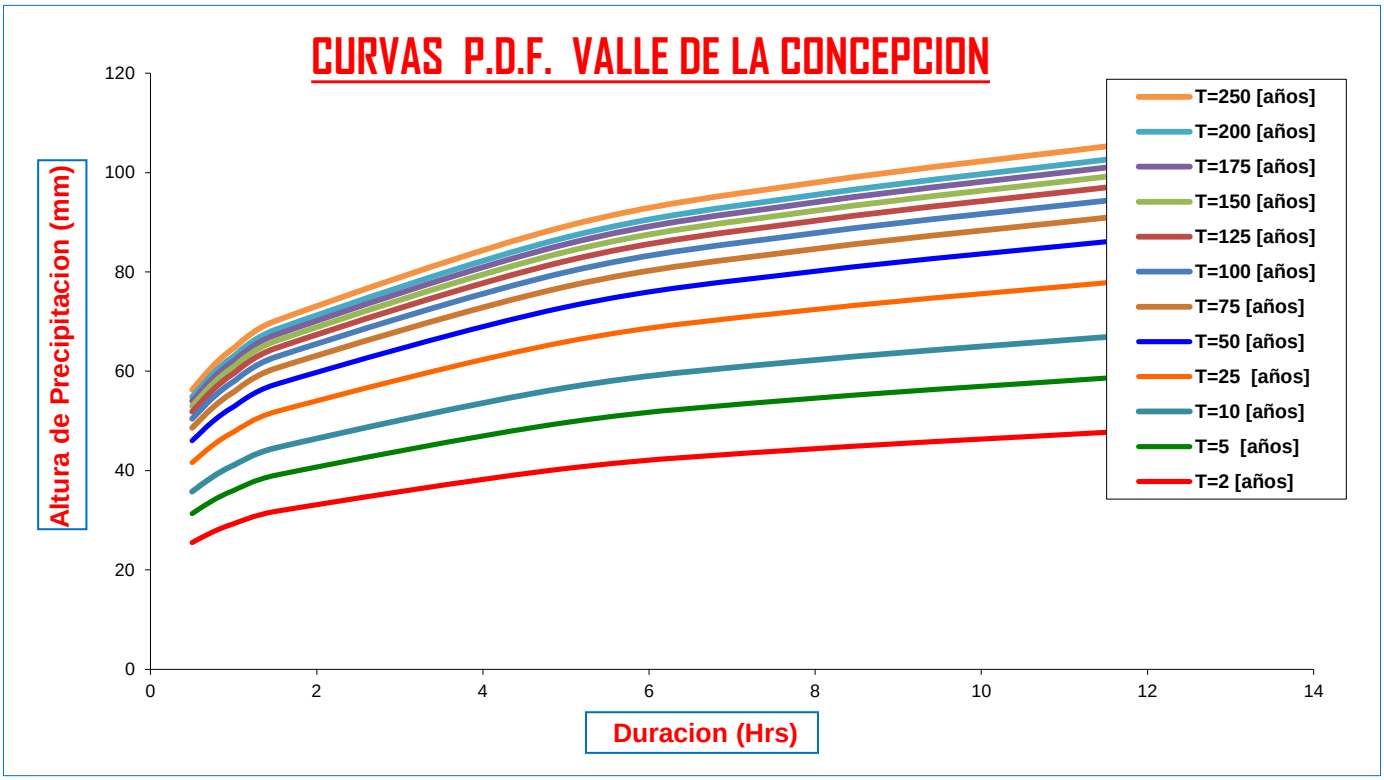
- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.2
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

Para A_c > 20 km^2 ⇒ α = 12
Para A_c < 20 km^2 ⇒ α = 2

Aplicando la Formula tenemos las lluvias Maxima Horarias:

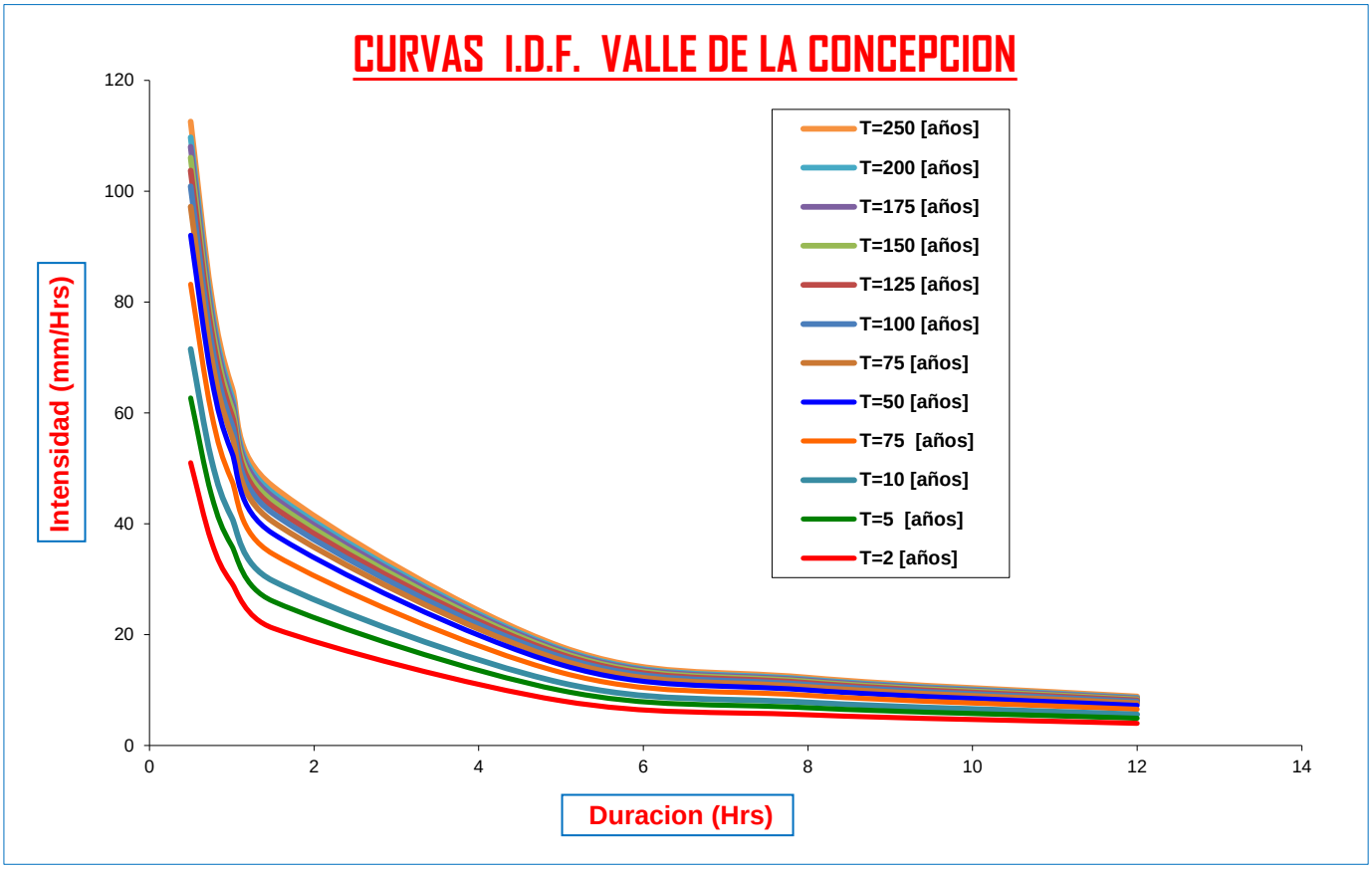
β = 0.2 ; α = 12 **Valor Adoptado**
E_d = 39.82 ; K_d = 0.70

Periodo de Retorno	Duracion de lluvia en (mm)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	25.51	27.66	29.30	31.78	40.43	44.41	48.16
5	31.35	33.99	36.01	39.05	49.68	54.58	59.19
10	35.76	38.79	41.08	44.55	56.68	62.27	67.53
25	41.60	45.12	47.79	51.83	65.94	72.44	78.56
50	46.02	49.91	52.87	57.33	72.94	80.13	86.90
75	48.61	52.71	55.83	60.55	77.04	84.63	91.78
100	50.44	54.70	57.94	62.83	79.94	87.82	95.24
125	51.86	56.24	59.57	64.61	82.19	90.30	97.92
150	53.02	57.50	60.91	66.05	84.04	92.32	100.12
175	54.01	58.57	62.04	67.28	85.59	94.03	101.97
200	54.86	59.49	63.01	68.34	86.94	95.51	103.58
250	56.28	61.03	64.65	70.11	89.20	97.99	106.26

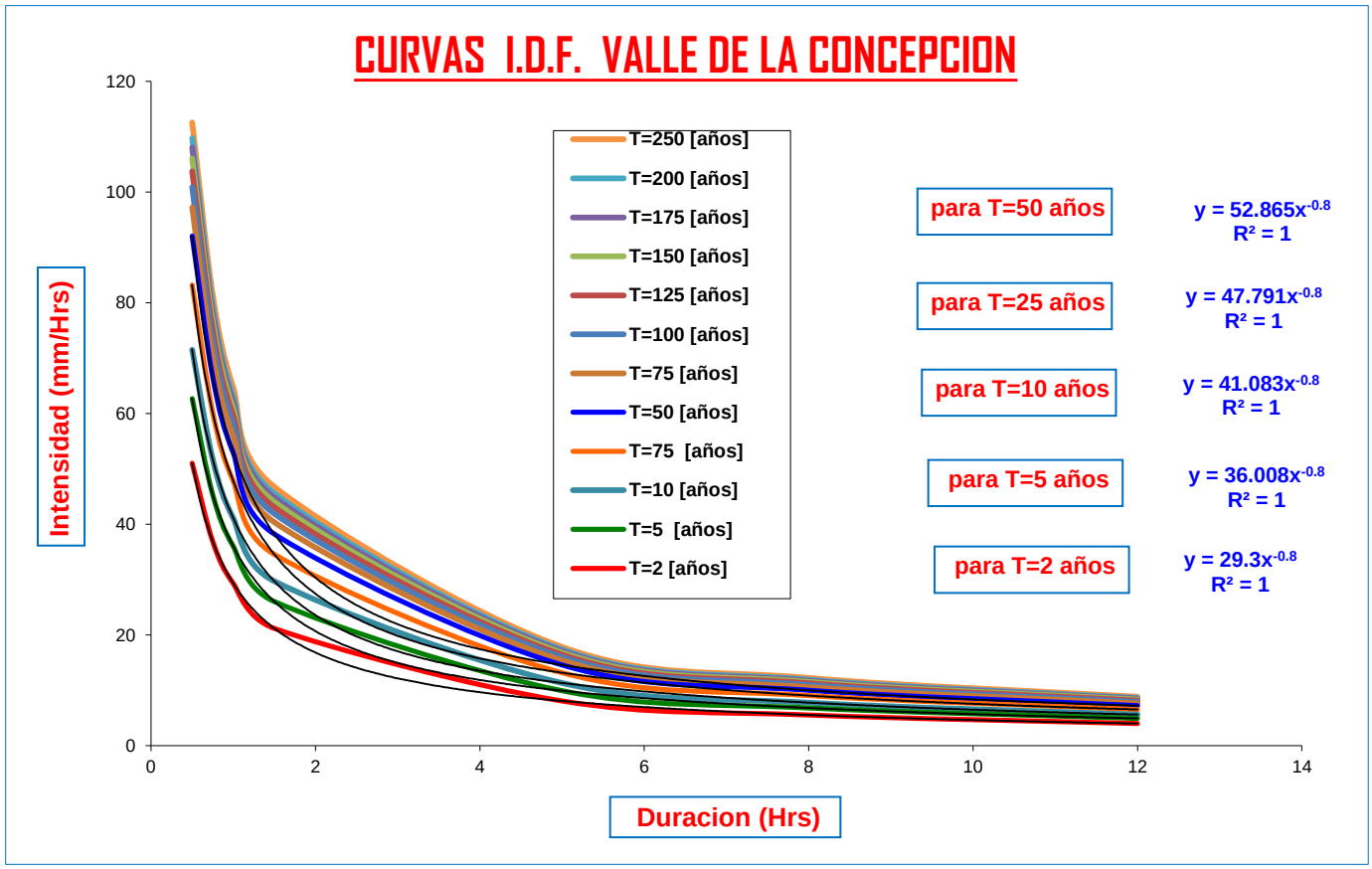


Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	51.01	36.88	29.30	21.18	8.09	5.55	4.01
5	62.69	45.33	36.01	26.03	9.94	6.82	4.93
10	71.53	51.71	41.08	29.70	11.34	7.78	5.63
25	83.21	60.16	47.79	34.55	13.19	9.05	6.55
50	92.04	66.55	52.87	38.22	14.59	10.02	7.24
75	97.21	70.28	55.83	40.37	15.41	10.58	7.65
100	100.88	72.93	57.94	41.89	15.99	10.98	7.94
125	103.72	74.99	59.57	43.07	16.44	11.29	8.16
150	106.05	76.67	60.91	44.04	16.81	11.54	8.34
175	108.01	78.09	62.04	44.85	17.12	11.75	8.50
200	109.71	79.32	63.01	45.56	17.39	11.94	8.63
250	112.56	81.38	64.65	46.74	17.84	12.25	8.86



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las Precipitaciones maximas anuales:

Año	Estaciones para la Ciudad de Villamontes		
	Villamontes	Palmar Grande	Sachapera
1	50		
2	131		
3	59		160.5
4	95		186
5	75.5		108.4
6	94		60
7	126		84.2
8	50.1		120
9	126.7		156
10	159		130
11	91		105
12	53.2	78.1	105
13	146.4	120	81.4
14	66.2	173.1	175
15	85.6	142.8	130.5
16	99.8	60.4	60.5
17	101.4	98.6	90.7
18	92.4	140.8	145.6
19	94.21	102.4	126.2
20	57.4	146	158.8
21	72.3	136	92.6
22	61.7	157.4	60
23	137.3	71.8	58.3
24	87.2	100.1	140
25	77.2	50	118
26	121.2	90.4	115.5
27	99.4	100.4	113.5
28	104.3	150.4	83
29	66.3	127.4	71.5
30	76.2	140	180
31	93.3	89.8	75.6

Calculos de las Medidas de Distribucion:

Media =	91.95	113.80	113.51
Desviacion =	29.07	34.47	38.16
Varianza =	845.28	1188.36	1456.32
N° de Datos =	31	20	29

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \bar{x} - 0.45\,S$$

Moda =	78.86	98.28	96.34

$$K = \frac{S}{0.557 * E}$$

Caracteristica	0.66	0.63	0.71

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° =	2444.73	1965.65	2793.79
K*N° =	20.52	12.59	20.62

Moda Ponderada: $$E_d = \frac{\sum E_i * n_i}{\sum n_i} =$$ 90.052

Caracteristica Ponderada: $$Kd = \frac{\sum K_i * n_i}{\sum n_i} =$$ 0.672

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- Ed = Moda Ponderada
- Kd = Caracteristica Ponderada
- T = Periodo de Retorno
- hdt = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	108.26
5	132.33
10	150.54
25	174.61
50	192.82
75	203.47
100	211.03
125	216.89
150	221.68
175	225.73
200	229.24

250	235.10

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota:

Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Donde:

- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.02
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

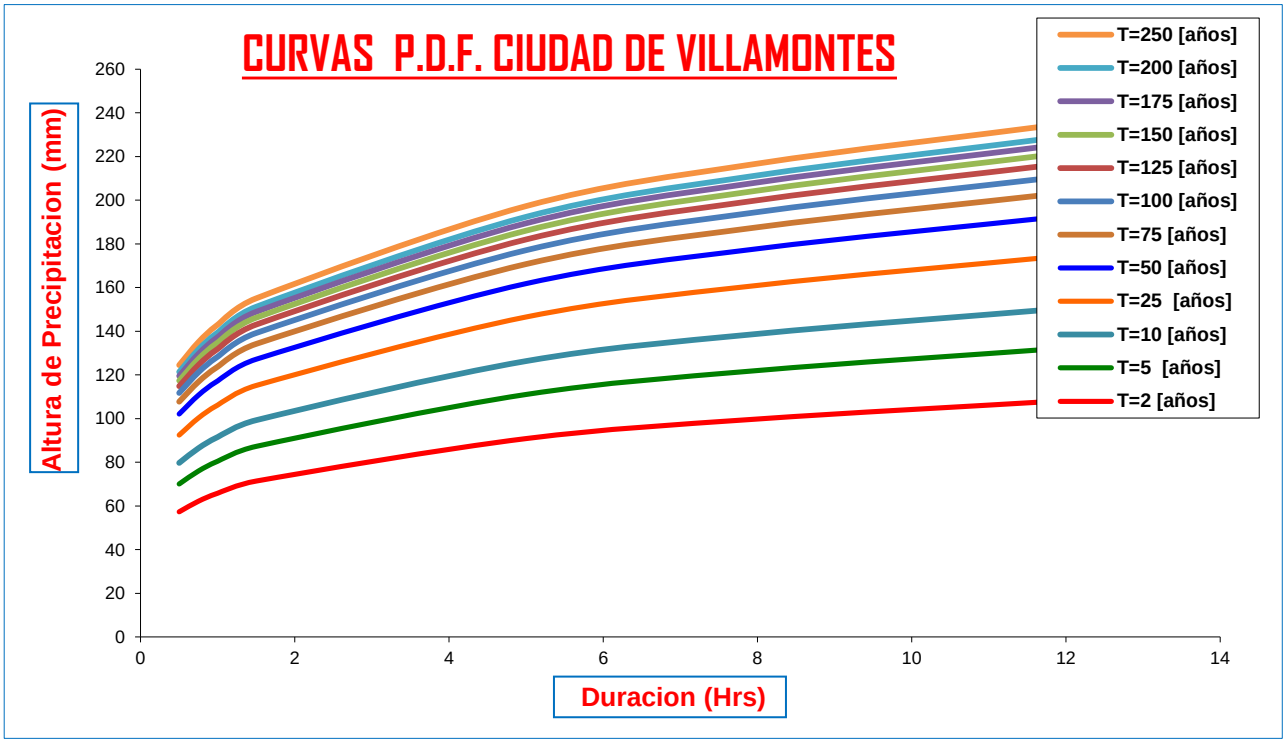
Para	A_c >	20	km^2	⇒	α =	12
Para	A_c <	20	km^2	⇒	α =	2

Aplicando la Formula tenemos las lluvias Maxima Horarias:

β = 0.2 ⇒ α = 12 **Valor Adoptado**

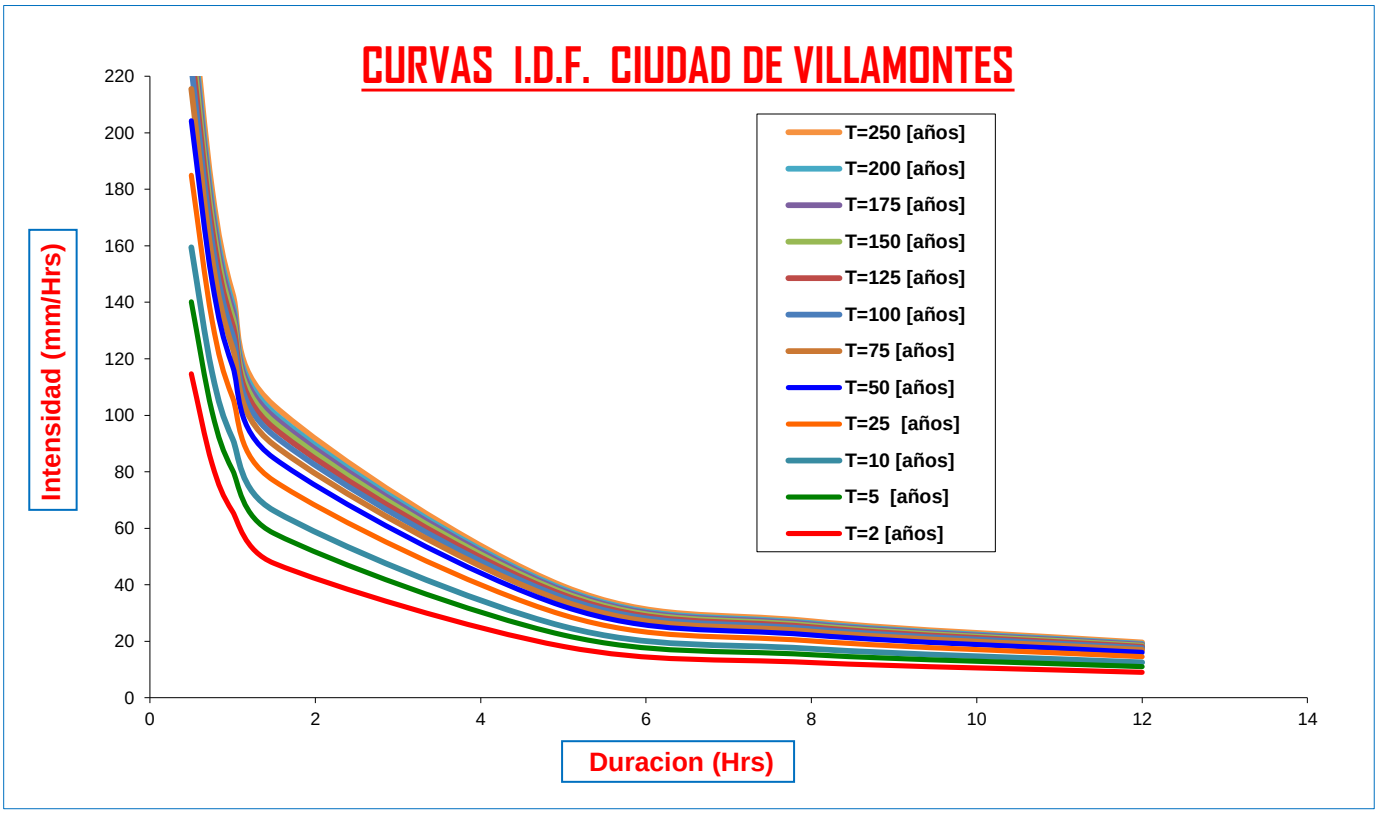
E_d = 90.05 ⇒ K_d = 0.67

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	57.34	62.18	65.86	71.43	90.87	99.83	108.26
5	70.08	76.00	80.51	87.31	111.08	122.02	132.33
10	79.73	86.46	91.58	99.32	126.36	138.81	150.54
25	92.48	100.29	106.23	115.20	146.57	161.01	174.61
50	102.12	110.75	117.31	127.21	161.85	177.80	192.82
75	107.76	116.86	123.79	134.24	170.79	187.62	203.47
100	111.76	121.20	128.38	139.23	177.13	194.59	211.03
125	114.87	124.57	131.95	143.09	182.05	200.00	216.89
150	117.40	127.32	134.86	146.25	186.07	204.41	221.68
175	119.55	129.65	137.33	148.93	189.47	208.15	225.73
200	121.41	131.66	139.46	151.24	192.42	211.38	229.24
250	124.51	135.03	143.03	155.11	197.34	216.79	235.10

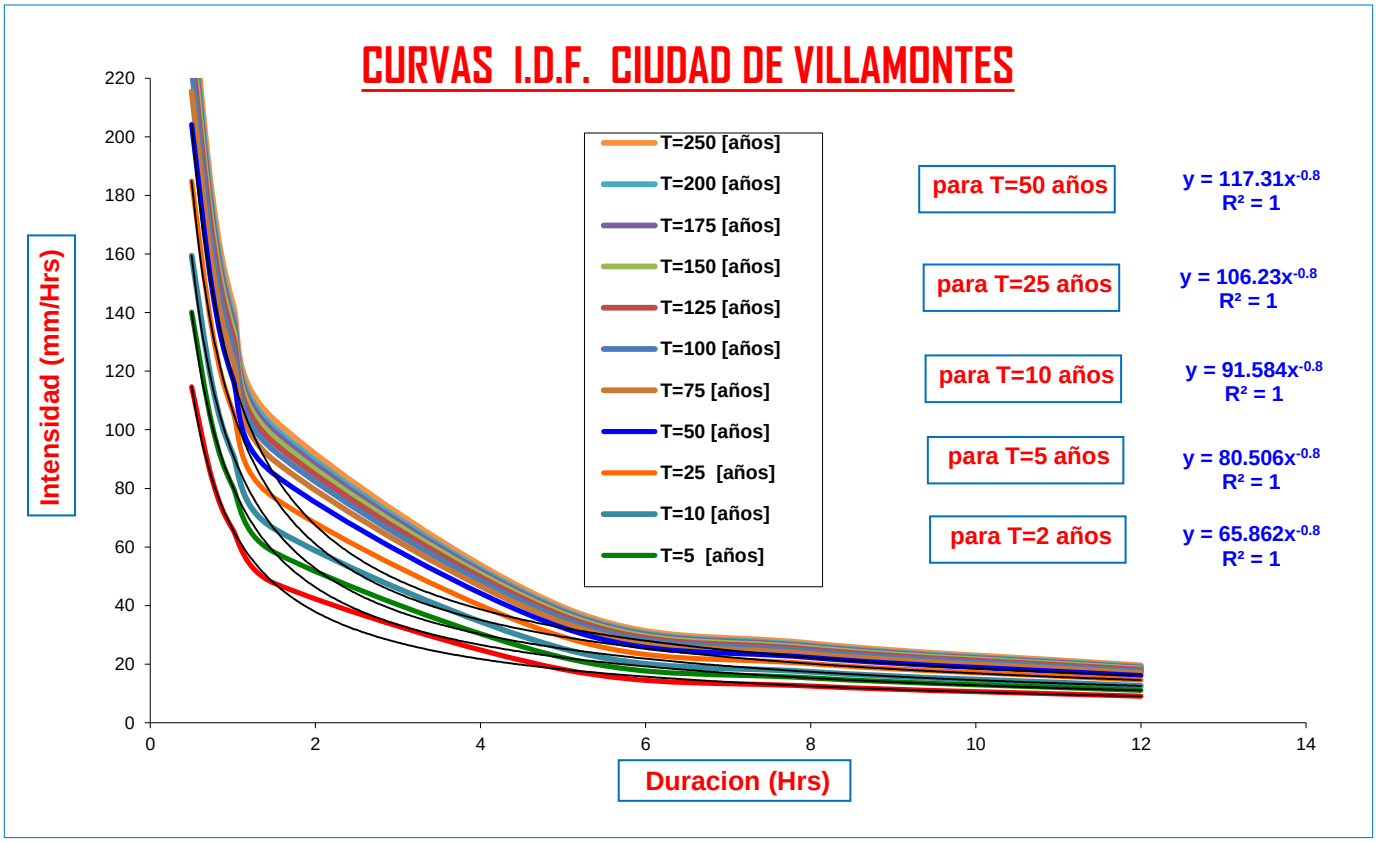


Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	114.67	82.91	65.86	47.62	18.17	12.48	9.02
5	140.17	101.34	80.51	58.20	22.22	15.25	11.03
10	159.46	115.28	91.58	66.21	25.27	17.35	12.55
25	184.95	133.72	106.23	76.80	29.31	20.13	14.55
50	204.24	147.66	117.31	84.81	32.37	22.23	16.07
75	215.52	155.82	123.79	89.49	34.16	23.45	16.96
100	223.53	161.61	128.38	92.82	35.43	24.32	17.59
125	229.74	166.10	131.95	95.40	36.41	25.00	18.07
150	234.81	169.76	134.86	97.50	37.21	25.55	18.47
175	239.10	172.86	137.33	99.28	37.89	26.02	18.81
200	242.81	175.55	139.46	100.83	38.48	26.42	19.10
250	249.02	180.04	143.03	103.41	39.47	27.10	19.59



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



CALCULO DE LLUVIAS MAXIMAS

Del Senanhi se extrayeron las Precipitaciones maximas anuales:

Año	Estaciones para la Ciudad de Yacuiba		
	Yacuiba	Palmar Chico	Algarrobillas
1	127		
2	90		
3	71		
4	65		
5	79.5		
6	66		
7	61		
8	73		
9	72		
10	75		
11	64		
12	54		
13	85		
14	230		
15	92		
16	144		
17	108	135.5	
18	110	129.1	
19	212.5	160	
20	178	102.4	
21	154	54.2	
22	87	123	
23	96	125.2	
24	99	136	
25	106	108.2	
26	71.8	110.2	
27	104	70.5	40
28	98.5	124.2	62.4
29	140	124.2	56.4
30	119.3	98.9	120
31	76	100	139
32	58.2	100.8	75
33	50.2	190	78
34	115.3	92.5	92.5
35	43.3	135.6	142
36	88.6	82.3	56.3
37	99.3	182	132.5
38	138.9	109.5	153.6

39	137.3	122.5	260.7
40	134.7	128.2	102.5
41	136.7	105	87.4
42	67.5	145	80.2
43	102.8	118	80.6
44	142	170.3	65.8

Calculos de las Medidas de Distribucion:

Media =	102.80	120.83	101.38
Desviacion =	40.87	30.73	51.73
Varianza =	1670.13	944.54	2676.29
N° de Datos =	44	28	18

Calculo de la Moda(E) y la Caracteristica (K) :

$$E = \bar{x} - 0.45\,S$$

Moda =	84.41	107.00	78.10

$$K = \frac{S}{0.557 * E}$$

Caracteristica	0.87	0.52	1.19

Calculo de la Moda Ponderada y la Caracteristica Ponderada:

E*N° =	3714.23	2996.06	1405.86
K*N° =	38.24	14.44	21.40

Moda Ponderada:

$$E_d = \frac{\sum E_i * n_i}{\sum n_i} =$$

90.179

Caracteristica Ponderada:

$$Kd = \frac{\sum K_i * n_i}{\sum n_i} =$$

0.823

APLICACIÓN DE LA LEY DE GUMBELL:

Determinacion de la altura de lluvia Diaria maxima para un Determinado Periodo de Retorno:

$$h_{dT} = Ed * [1 + kd * \log(T)]$$

Donde :

- Ed = Moda Ponderada
- Kd = Caracteristica Ponderada
- T = Periodo de Retorno
- hdt = Altura de lluvia Maxima Diaria

Aplicando la Formula tenemos:

Periodo de Retorno en (años)	Altura de lluvia Diaria Maxima en (mm)
2	112.53
5	142.07
10	164.41
25	193.95
50	216.30
75	229.37
100	238.65
125	245.84
150	251.72
175	256.69
200	261.00
250	268.19

Determinacion de la altura de lluvia Maxima Horaria para un determinado periodo de Retorno "T" y un tiempo de duracion "t":

Nota: Las lluvias Maximas deben ser de corta Duracion es decir que deben ser menores a 24 Hrs. para lo cual acudimos a la Ley de Gumbell Modificada que esta definido por la siguiente Exprecion:

$$h_{tT} = Ed * \left(\frac{t}{\alpha}\right)^{\beta} * [1 + Kd * \log(T)]$$

Donde:

- E_d = Moda Ponderada
- K_d = Caracteristica Ponderada
- T = Periodo de Retorno
- h_{tT} = Altura de lluvia Maxima Horaria
- t= Tiempo de Duracion de la Lluvia
- β = Constante que en nuestro medio se adopta generalmente 0.02
- α = Equivalente de lluvia Diaria que depende de la Magnitud de la cuenca

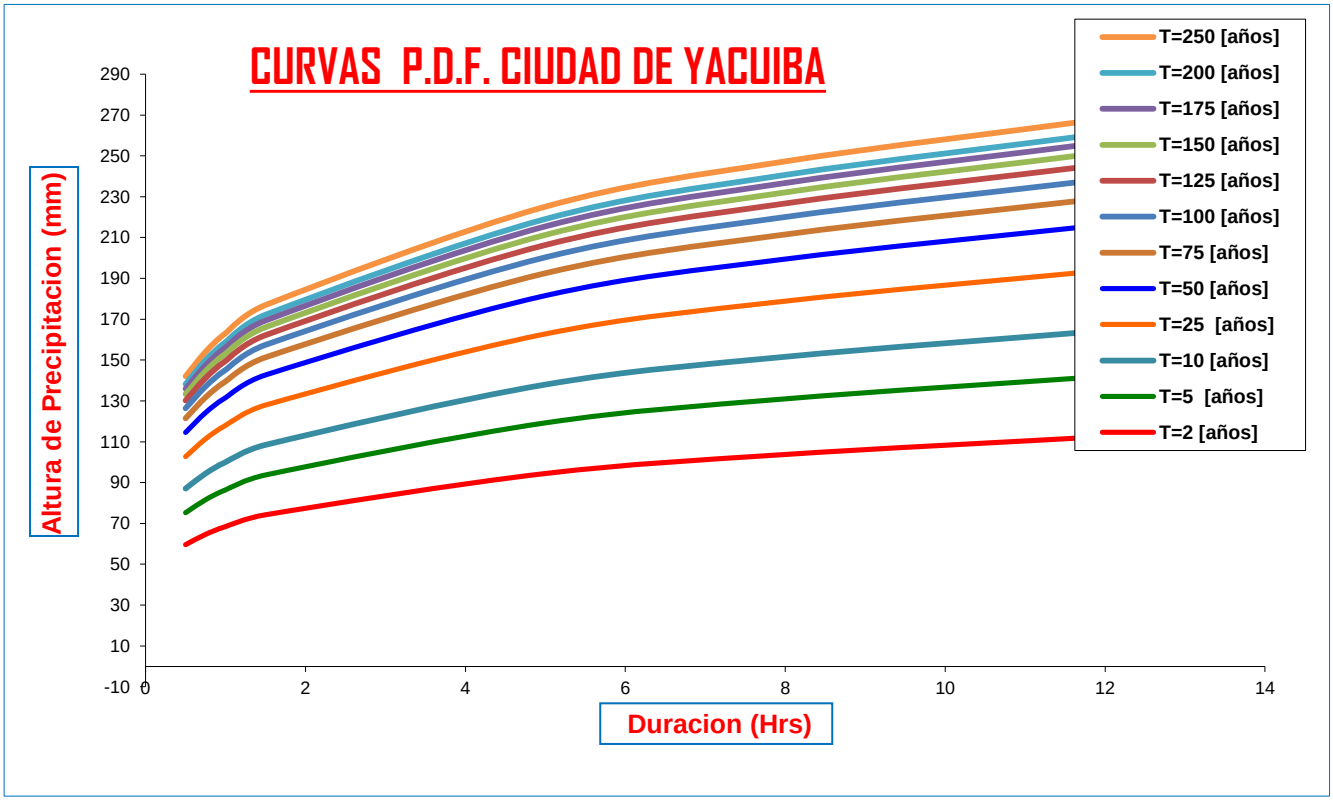
Para A_c > 20 km^2 ⇒ α = 12
Para A_c < 20 km^2 ⇒ α = 2

Aplicando la Formula tenemos las lluvias Maxima Horarias:

⇒ β = 0.2
⇒ E_d = 90.18
⇒ α = 12 **Valor Adoptado**
⇒ K_d = 0.82

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	59.60	64.63	68.46	74.24	94.45	103.76	112.53
5	75.24	81.60	86.43	93.73	119.25	131.00	142.07
10	87.08	94.43	100.02	108.47	138.01	151.61	164.41

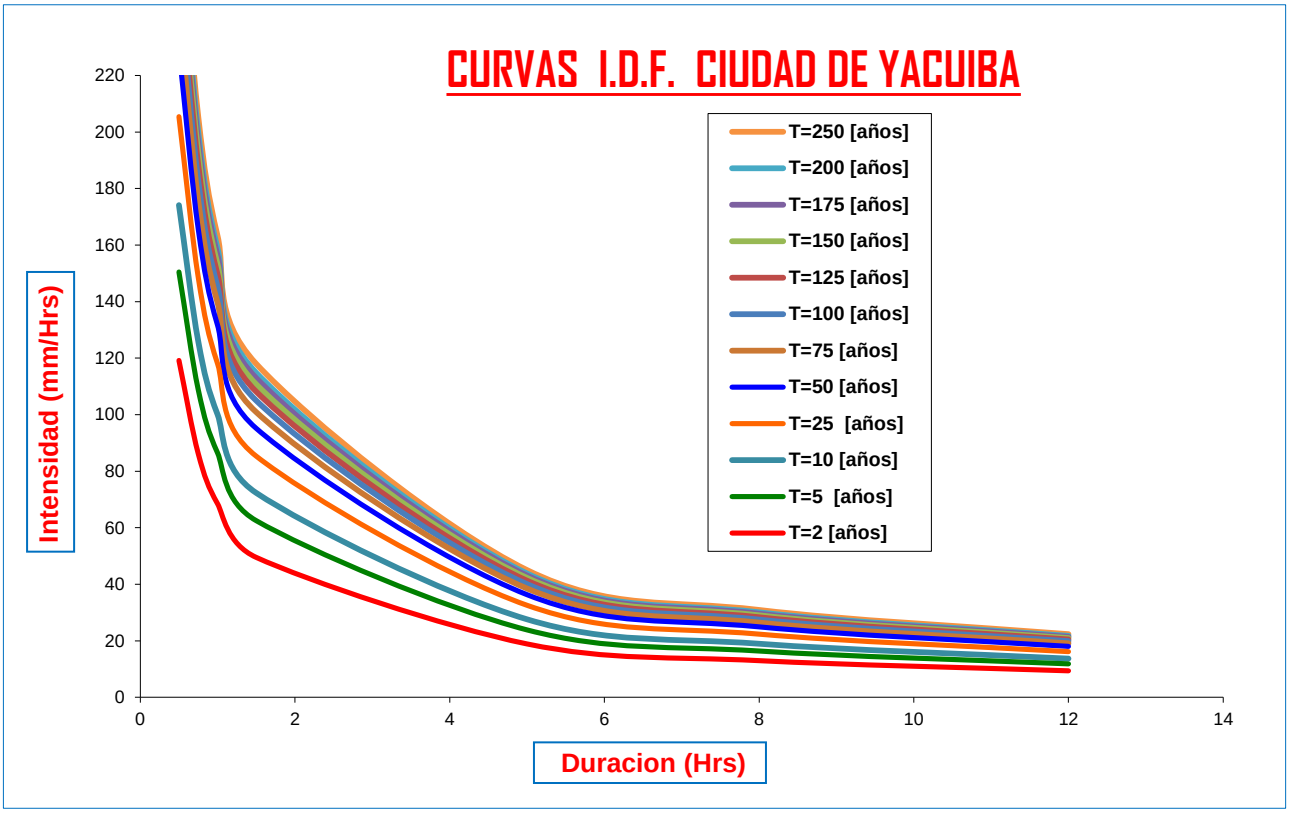
25	102.72	111.40	118.00	127.96	162.80	178.85	193.95
50	114.56	124.23	131.59	142.71	181.56	199.45	216.30
75	121.48	131.74	139.54	151.33	192.53	211.51	229.37
100	126.39	137.07	145.19	157.45	200.32	220.06	238.65
125	130.20	141.20	149.56	162.20	206.35	226.69	245.84
150	133.31	144.58	153.14	166.07	211.29	232.11	251.72
175	135.95	147.43	156.16	169.35	215.46	236.70	256.69
200	138.23	149.90	158.78	172.19	219.07	240.67	261.00
250	142.04	154.03	163.16	176.94	225.11	247.30	268.19



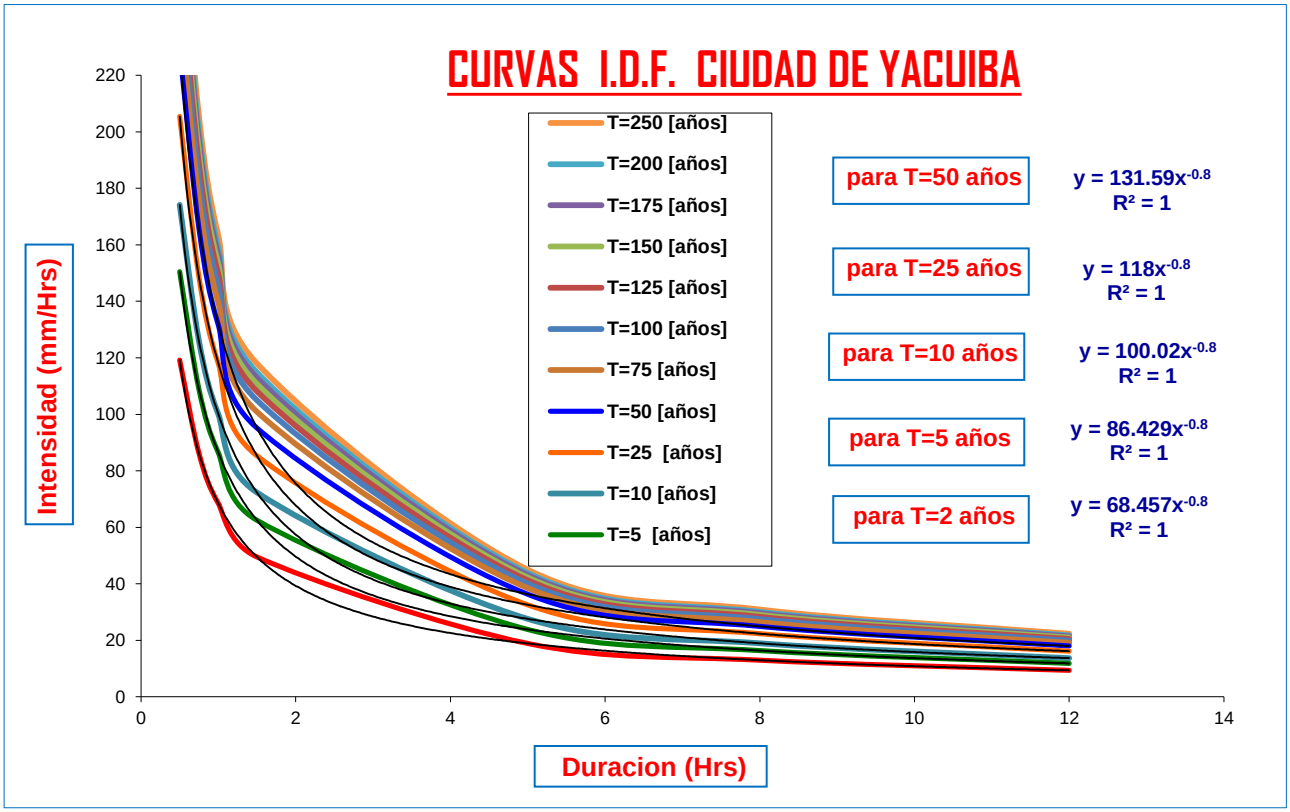
Calculo de Intensidades en (mm/Hrs)

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	**0.75**	**1**	**1.5**	**5**	**8**	**12**
2	119.19	86.17	68.46	49.49	18.89	12.97	9.38
5	150.48	108.79	86.43	62.49	23.85	16.38	11.84
10	174.15	125.91	100.02	72.32	27.60	18.95	13.70
25	205.44	148.53	118.00	85.31	32.56	22.36	16.16
50	229.11	165.64	131.59	95.14	36.31	24.93	18.03
75	242.96	175.65	139.54	100.89	38.51	26.44	19.11
100	252.78	182.76	145.19	104.97	40.06	27.51	19.89
125	260.40	188.27	149.56	108.13	41.27	28.34	20.49
150	266.63	192.77	153.14	110.72	42.26	29.01	20.98
175	271.89	196.57	156.16	112.90	43.09	29.59	21.39
200	276.45	199.87	158.78	114.80	43.81	30.08	21.75

250	284.07	205.38	163.16	117.96	45.02	30.91	22.35



CURVAS AJUSTADAS DE INTENSIDADES EN FUNCION DE LA DURACION DE LA LLUVIA PARA DIFERENTES "T"



APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

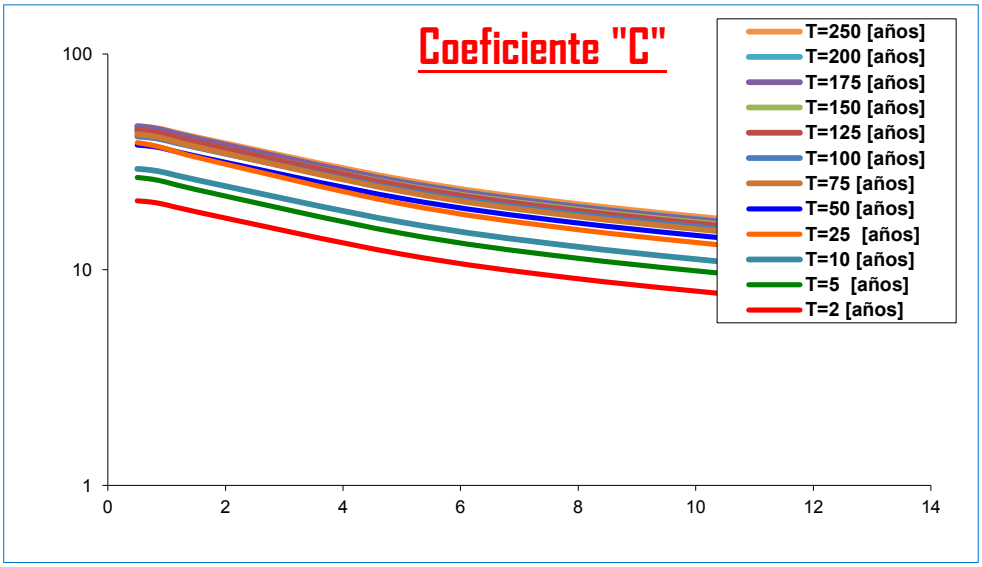
$$i = \frac{K * T_{\text{Re torno}}^{\ a}}{(D_{Duracion} + C)^b} \quad \Leftrightarrow \quad i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	20.84	20.55	19.95	18.54	11.80	9.07	7.03
5	26.73	26.25	25.41	23.51	14.74	11.28	8.71
10	29.31	28.89	28.05	26.08	16.59	12.76	9.88
25	38.78	37.77	36.30	33.21	20.18	15.31	11.76
50	37.77	37.24	36.16	33.61	21.38	16.44	12.74
75	42.45	41.61	40.21	37.10	23.08	17.64	13.60
100	41.42	40.84	39.65	36.86	23.45	18.03	13.97
125	44.37	43.58	42.18	39.02	24.46	18.73	14.47
150	43.55	42.94	41.69	38.75	24.65	18.96	14.69
175	46.21	45.39	43.93	40.64	25.48	19.51	15.07
200	45.07	44.43	43.14	40.10	25.51	19.62	15.20
250	46.24	45.59	44.26	41.15	26.17	20.13	15.59

Periodo (T)	C (Adoptado)
2	2
5	1.9
10	2
25	1.7
50	2
75	1.85
100	2
125	1.9
150	2
175	1.9
200	2
250	2



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} =$$ 1.9375 $$\theta = \frac{\sum \theta_i}{K} =$$ 2.0

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X1 = Log T	X2 = Log D
1	2	104.20	30	2.0179	0.3010	1.4771
2	5	128.31	30	2.1082	0.6990	1.4771
3	10	146.54	30	2.1660	1.0000	1.4771
4	25	170.64	30	2.2321	1.3979	1.4771
5	50	188.87	30	2.2762	1.6990	1.4771
6	75	199.54	30	2.3000	1.8751	1.4771
7	100	207.11	30	2.3162	2.0000	1.4771
8	125	212.98	30	2.3283	2.0969	1.4771
9	150	217.77	30	2.3380	2.1761	1.4771
10	175	221.83	30	2.3460	2.2430	1.4771
11	200	225.34	30	2.3528	2.3010	1.4771
12	250	231.21	30	2.3640	2.3979	1.4771
13	2	75.34	45	1.8770	0.3010	1.6532
14	5	92.76	45	1.9674	0.6990	1.6532
15	10	105.94	45	2.0251	1.0000	1.6532
16	25	123.37	45	2.0912	1.3979	1.6532
17	50	136.55	45	2.1353	1.6990	1.6532
18	75	144.26	45	2.1592	1.8751	1.6532
19	100	149.73	45	2.1753	2.0000	1.6532
20	125	153.98	45	2.1875	2.0969	1.6532
21	150	157.44	45	2.1971	2.1761	1.6532
22	175	160.38	45	2.2051	2.2430	1.6532
23	200	162.92	45	2.2120	2.3010	1.6532
24	250	167.16	45	2.2231	2.3979	1.6532
25	2	59.85	60	1.7771	0.3010	1.7782
26	5	73.69	60	1.8674	0.6990	1.7782
27	10	84.16	60	1.9251	1.0000	1.7782
28	25	98.01	60	1.9913	1.3979	1.7782
29	50	108.48	60	2.0353	1.6990	1.7782
30	75	114.60	60	2.0592	1.8751	1.7782
31	100	118.95	60	2.0754	2.0000	1.7782
32	125	122.32	60	2.0875	2.0969	1.7782
33	150	125.08	60	2.0972	2.1761	1.7782

34	175	127.41	60	2.1052	2.2430	1.7782
35	200	129.42	60	2.1120	2.3010	1.7782
36	250	132.79	60	2.1232	2.3979	1.7782
37	2	43.27	90	1.6362	0.3010	1.9542
38	5	53.28	90	1.7266	0.6990	1.9542
39	10	60.85	90	1.7843	1.0000	1.9542
40	25	70.86	90	1.8504	1.3979	1.9542
41	50	78.43	90	1.8945	1.6990	1.9542
42	75	82.86	90	1.9183	1.8751	1.9542
43	100	86.00	90	1.9345	2.0000	1.9542
44	125	88.44	90	1.9466	2.0969	1.9542
45	150	90.43	90	1.9563	2.1761	1.9542
46	175	92.11	90	1.9643	2.2430	1.9542
47	200	93.57	90	1.9711	2.3010	1.9542
48	250	96.01	90	1.9823	2.3979	1.9542
49	2	16.52	300	1.2179	0.3010	2.4771
50	5	20.34	300	1.3082	0.6990	2.4771
51	10	23.22	300	1.3660	1.0000	2.4771
52	25	27.04	300	1.4321	1.3979	2.4771
53	50	29.93	300	1.4762	1.6990	2.4771
54	75	31.62	300	1.5000	1.8751	2.4771
55	100	32.82	300	1.5162	2.0000	2.4771
56	125	33.75	300	1.5283	2.0969	2.4771
57	150	34.51	300	1.5380	2.1761	2.4771
58	175	35.16	300	1.5460	2.2430	2.4771
59	200	35.71	300	1.5528	2.3010	2.4771
60	250	36.64	300	1.5640	2.3979	2.4771
61	2	11.34	480	1.0546	0.3010	2.6812
62	5	13.96	480	1.1450	0.6990	2.6812
63	10	15.95	480	1.2027	1.0000	2.6812
64	25	18.57	480	1.2688	1.3979	2.6812
65	50	20.55	480	1.3129	1.6990	2.6812
66	75	21.71	480	1.3367	1.8751	2.6812
67	100	22.54	480	1.3529	2.0000	2.6812
68	125	23.18	480	1.3650	2.0969	2.6812
69	150	23.70	480	1.3747	2.1761	2.6812
70	175	24.14	480	1.3827	2.2430	2.6812
71	200	24.52	480	1.3895	2.3010	2.6812
72	250	25.16	480	1.4007	2.3979	2.6812
73	2	8.20	720	0.9137	0.3010	2.8573
74	5	10.09	720	1.0041	0.6990	2.8573
75	10	11.53	720	1.0618	1.0000	2.8573
76	25	13.42	720	1.1279	1.3979	2.8573
77	50	14.86	720	1.1720	1.6990	2.8573
78	75	15.70	720	1.1959	1.8751	2.8573
79	100	16.29	720	1.2120	2.0000	2.8573
80	125	16.76	720	1.2242	2.0969	2.8573

81	150	17.13	720	1.2338	2.1761	2.8573
82	175	17.45	720	1.2418	2.2430	2.8573
83	200	17.73	720	1.2487	2.3010	2.8573
84	250	18.19	720	1.2598	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	$Y*X_1$	$Y*X_2$	X_1*X_2	X_1^2	X_2^2
1	2	0.6074	2.9807	0.4447	0.0906	2.1819
2	5	1.4736	3.1141	1.0325	0.4886	2.1819
3	10	2.1660	3.1994	1.4771	1.0000	2.1819
4	25	3.1203	3.2971	2.0649	1.9542	2.1819
5	50	3.8671	3.3622	2.5096	2.8865	2.1819
6	75	4.3127	3.3974	2.7697	3.5159	2.1819
7	100	4.6324	3.4213	2.9542	4.0000	2.1819
8	125	4.8823	3.4392	3.0974	4.3970	2.1819
9	150	5.0877	3.4535	3.2144	4.7354	2.1819
10	175	5.2622	3.4653	3.3132	5.0312	2.1819
11	200	5.4139	3.4754	3.3989	5.2947	2.1819
12	250	5.6687	3.4919	3.5420	5.7501	2.1819
13	2	0.5650	3.1031	0.4977	0.0906	2.7331
14	5	1.3751	3.2525	1.1555	0.4886	2.7331
15	10	2.0251	3.3479	1.6532	1.0000	2.7331
16	25	2.9234	3.4572	2.3111	1.9542	2.7331
17	50	3.6278	3.5301	2.8088	2.8865	2.7331
18	75	4.0485	3.5695	3.0999	3.5159	2.7331
19	100	4.3506	3.5963	3.3064	4.0000	2.7331
20	125	4.5869	3.6163	3.4666	4.3970	2.7331
21	150	4.7811	3.6323	3.5975	4.7354	2.7331
22	175	4.9462	3.6456	3.7082	5.0312	2.7331
23	200	5.0898	3.6568	3.8041	5.2947	2.7331
24	250	5.3309	3.6753	3.9643	5.7501	2.7331
25	2	0.5349	3.1599	0.5353	0.0906	3.1618
26	5	1.3053	3.3206	1.2429	0.4886	3.1618
27	10	1.9251	3.4232	1.7782	1.0000	3.1618
28	25	2.7837	3.5408	2.4857	1.9542	3.1618
29	50	3.4580	3.6192	3.0210	2.8865	3.1618
30	75	3.8611	3.6616	3.3341	3.5159	3.1618
31	100	4.1507	3.6903	3.5563	4.0000	3.1618
32	125	4.3773	3.7119	3.7286	4.3970	3.1618
33	150	4.5636	3.7291	3.8694	4.7354	3.1618
34	175	4.7220	3.7433	3.9885	5.0312	3.1618
35	200	4.8598	3.7555	4.0916	5.2947	3.1618
36	250	5.0913	3.7753	4.2639	5.7501	3.1618
37	2	0.4925	3.1975	0.5883	0.0906	3.8191
38	5	1.2068	3.3741	1.3660	0.4886	3.8191

39	10	1.7843	3.4869	1.9542	1.0000	3.8191
40	25	2.5867	3.6161	2.7319	1.9542	3.8191
41	50	3.2187	3.7023	3.3202	2.8865	3.8191
42	75	3.5970	3.7489	3.6643	3.5159	3.8191
43	100	3.8690	3.7805	3.9085	4.0000	3.8191
44	125	4.0819	3.8042	4.0979	4.3970	3.8191
45	150	4.2571	3.8231	4.2526	4.7354	3.8191
46	175	4.4060	3.8387	4.3834	5.0312	3.8191
47	200	4.5356	3.8521	4.4968	5.2947	3.8191
48	250	4.7534	3.8739	4.6862	5.7501	3.8191
49	2	0.3666	3.0168	0.7457	0.0906	6.1361
50	5	0.9144	3.2407	1.7314	0.4886	6.1361
51	10	1.3660	3.3836	2.4771	1.0000	6.1361
52	25	2.0020	3.5474	3.4629	1.9542	6.1361
53	50	2.5080	3.6567	4.2086	2.8865	6.1361
54	75	2.8126	3.7157	4.6448	3.5159	6.1361
55	100	3.0324	3.7558	4.9542	4.0000	6.1361
56	125	3.2048	3.7859	5.1943	4.3970	6.1361
57	150	3.3468	3.8098	5.3904	4.7354	6.1361
58	175	3.4678	3.8297	5.5563	5.0312	6.1361
59	200	3.5731	3.8466	5.6999	5.2947	6.1361
60	250	3.7504	3.8742	5.9400	5.7501	6.1361
61	2	0.3175	2.8276	0.8071	0.0906	7.1891
62	5	0.8003	3.0699	1.8741	0.4886	7.1891
63	10	1.2027	3.2246	2.6812	1.0000	7.1891
64	25	1.7737	3.4019	3.7482	1.9542	7.1891
65	50	2.2305	3.5201	4.5553	2.8865	7.1891
66	75	2.5065	3.5841	5.0275	3.5159	7.1891
67	100	2.7058	3.6274	5.3625	4.0000	7.1891
68	125	2.8624	3.6600	5.6223	4.3970	7.1891
69	150	2.9915	3.6859	5.8346	4.7354	7.1891
70	175	3.1015	3.7074	6.0141	5.0312	7.1891
71	200	3.1974	3.7257	6.1696	5.2947	7.1891
72	250	3.3588	3.7556	6.4295	5.7501	7.1891
73	2	0.2751	2.6108	0.8601	0.0906	8.1643
74	5	0.7018	2.8690	1.9972	0.4886	8.1643
75	10	1.0618	3.0339	2.8573	1.0000	8.1643
76	25	1.5768	3.2228	3.9944	1.9542	8.1643
77	50	1.9912	3.3488	4.8545	2.8865	8.1643
78	75	2.2423	3.4170	5.3577	3.5159	8.1643
79	100	2.4240	3.4632	5.7147	4.0000	8.1643
80	125	2.5670	3.4978	5.9916	4.3970	8.1643
81	150	2.6849	3.5255	6.2178	4.7354	8.1643
82	175	2.7855	3.5484	6.4091	5.0312	8.1643
83	200	2.8732	3.5679	6.5748	5.2947	8.1643
84	250	3.0210	3.5998	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 146.450 $\quad \sum X_1 =$ 141.309

$\sum X_2 =$ 178.541 $\quad \sum Y * X_1 =$ 252.165

$\sum Y * X_2 =$ 294.367 $\quad \sum X_1 * X_2 =$ 300.350

$\sum X_1^{\,2} =$ 274.010 $\quad \sum X_2^{\,2} =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{\left(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}{\left(\sum (X_1 X_2) * \sum X_2 - \sum X_2^2 * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}$$

$C =$ -0.800000

$B =$ 0.1598038

$A =$ 3.17501174

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A =$ 1496.27612

$a = B =$ 0.1598038

$b = -C =$ 0.800000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

$\lambda =$ 1496.3

$\psi =$ 0.1598038

$\eta =$ 0.80

$\theta =$ 2.0

APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

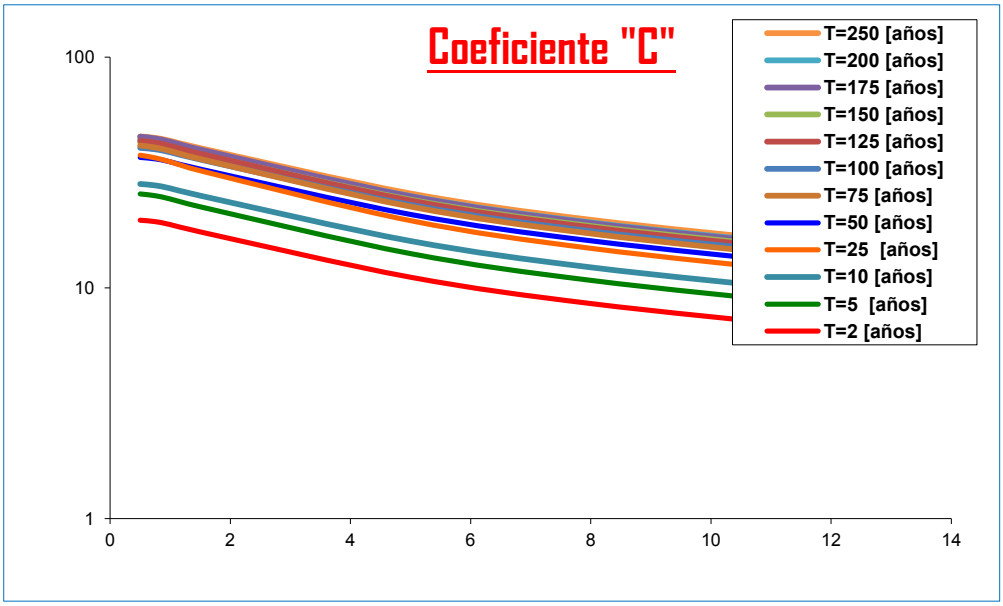
$$i = \frac{K * T_{\text{Re torno}}^{\ a}}{(D_{Duracion} + C)^b} \Longleftrightarrow i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	19.66	19.38	18.82	17.49	11.13	8.56	6.63
5	25.56	25.10	24.29	22.47	14.09	10.79	8.33
10	28.22	27.82	27.01	25.11	15.97	12.28	9.52
25	37.61	36.62	35.20	32.21	19.57	14.85	11.40
50	36.78	36.26	35.21	32.73	20.82	16.01	12.40
75	41.42	40.60	39.24	36.20	22.52	17.21	13.27
100	40.47	39.90	38.74	36.01	22.91	17.62	13.65
125	43.39	42.62	41.25	38.16	23.92	18.32	14.15
150	42.63	42.02	40.80	37.93	24.13	18.55	14.37
175	45.26	44.45	43.02	39.80	24.95	19.10	14.75
200	44.16	43.53	42.27	39.29	24.99	19.22	14.89
250	45.34	44.70	43.40	40.35	25.67	19.74	15.29

Periodo (T)	C (Adoptado)
2	2
5	1.9
10	2
25	1.7
50	2
75	1.85
100	2
125	1.9
150	2
175	1.9
200	2
250	2



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} = 1.9375 \qquad \theta = \frac{\sum \theta_i}{K} = 2.0$$

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X1 = Log T	X2 = Log D
1	2	98.30	30	1.9925	0.3010	1.4771
2	5	122.67	30	2.0887	0.6990	1.4771
3	10	141.10	30	2.1495	1.0000	1.4771
4	25	165.48	30	2.2187	1.3979	1.4771
5	50	183.91	30	2.2646	1.6990	1.4771
6	75	194.69	30	2.2894	1.8751	1.4771
7	100	202.35	30	2.3061	2.0000	1.4771
8	125	208.28	30	2.3187	2.0969	1.4771
9	150	213.13	30	2.3286	2.1761	1.4771
10	175	217.23	30	2.3369	2.2430	1.4771
11	200	220.78	30	2.3440	2.3010	1.4771
12	250	226.72	30	2.3555	2.3979	1.4771
13	2	71.07	45	1.8517	0.3010	1.6532
14	5	88.69	45	1.9479	0.6990	1.6532
15	10	102.02	45	2.0087	1.0000	1.6532
16	25	119.64	45	2.0779	1.3979	1.6532
17	50	132.96	45	2.1237	1.6990	1.6532
18	75	140.76	45	2.1485	1.8751	1.6532
19	100	146.29	45	2.1652	2.0000	1.6532
20	125	150.58	45	2.1778	2.0969	1.6532
21	150	154.09	45	2.1878	2.1761	1.6532
22	175	157.05	45	2.1960	2.2430	1.6532
23	200	159.62	45	2.2031	2.3010	1.6532
24	250	163.91	45	2.2146	2.3979	1.6532
25	2	56.46	60	1.7517	0.3010	1.7782
26	5	70.45	60	1.8479	0.6990	1.7782
27	10	81.04	60	1.9087	1.0000	1.7782
28	25	95.04	60	1.9779	1.3979	1.7782
29	50	105.63	60	2.0238	1.6990	1.7782
30	75	111.82	60	2.0485	1.8751	1.7782
31	100	116.22	60	2.0653	2.0000	1.7782
32	125	119.63	60	2.0778	2.0969	1.7782
33	150	122.41	60	2.0878	2.1761	1.7782
34	175	124.77	60	2.0961	2.2430	1.7782
35	200	126.81	60	2.1031	2.3010	1.7782
36	250	130.21	60	2.1147	2.3979	1.7782

37	2	40.82	90	1.6109	0.3010	1.9542
38	5	50.94	90	1.7070	0.6990	1.9542
39	10	58.59	90	1.7678	1.0000	1.9542
40	25	68.71	90	1.8370	1.3979	1.9542
41	50	76.37	90	1.8829	1.6990	1.9542
42	75	80.85	90	1.9077	1.8751	1.9542
43	100	84.02	90	1.9244	2.0000	1.9542
44	125	86.49	90	1.9370	2.0969	1.9542
45	150	88.50	90	1.9469	2.1761	1.9542
46	175	90.20	90	1.9552	2.2430	1.9542
47	200	91.68	90	1.9623	2.3010	1.9542
48	250	94.14	90	1.9738	2.3979	1.9542
49	2	15.58	300	1.1925	0.3010	2.4771
50	5	19.44	300	1.2887	0.6990	2.4771
51	10	22.36	300	1.3495	1.0000	2.4771
52	25	26.23	300	1.4187	1.3979	2.4771
53	50	29.15	300	1.4646	1.6990	2.4771
54	75	30.86	300	1.4894	1.8751	2.4771
55	100	32.07	300	1.5061	2.0000	2.4771
56	125	33.01	300	1.5187	2.0969	2.4771
57	150	33.78	300	1.5286	2.1761	2.4771
58	175	34.43	300	1.5369	2.2430	2.4771
59	200	34.99	300	1.5440	2.3010	2.4771
60	250	35.93	300	1.5555	2.3979	2.4771
61	2	10.70	480	1.0293	0.3010	2.6812
62	5	13.35	480	1.1254	0.6990	2.6812
63	10	15.35	480	1.1862	1.0000	2.6812
64	25	18.01	480	1.2554	1.3979	2.6812
65	50	20.01	480	1.3013	1.6990	2.6812
66	75	21.19	480	1.3261	1.8751	2.6812
67	100	22.02	480	1.3428	2.0000	2.6812
68	125	22.66	480	1.3554	2.0969	2.6812
69	150	23.19	480	1.3653	2.1761	2.6812
70	175	23.64	480	1.3736	2.2430	2.6812
71	200	24.03	480	1.3807	2.3010	2.6812
72	250	24.67	480	1.3922	2.3979	2.6812
73	2	7.73	720	0.8884	0.3010	2.8573
74	5	9.65	720	0.9846	0.6990	2.8573
75	10	11.10	720	1.0454	1.0000	2.8573
76	25	13.02	720	1.1146	1.3979	2.8573
77	50	14.47	720	1.1604	1.6990	2.8573
78	75	15.32	720	1.1852	1.8751	2.8573
79	100	15.92	720	1.2019	2.0000	2.8573
80	125	16.39	720	1.2145	2.0969	2.8573
81	150	16.77	720	1.2245	2.1761	2.8573
82	175	17.09	720	1.2328	2.2430	2.8573
83	200	17.37	720	1.2398	2.3010	2.8573

84	250	17.84	720	1.2513	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	Y*X1	Y*X2	X1*X2	X1^2	X2^2
1	2	0.5998	2.9432	0.4447	0.0906	2.1819
2	5	1.4600	3.0853	1.0325	0.4886	2.1819
3	10	2.1495	3.1751	1.4771	1.0000	2.1819
4	25	3.1017	3.2773	2.0649	1.9542	2.1819
5	50	3.8475	3.3451	2.5096	2.8865	2.1819
6	75	4.2927	3.3817	2.7697	3.5159	2.1819
7	100	4.6122	3.4064	2.9542	4.0000	2.1819
8	125	4.8620	3.4249	3.0974	4.3970	2.1819
9	150	5.0673	3.4397	3.2144	4.7354	2.1819
10	175	5.2418	3.4519	3.3132	5.0312	2.1819
11	200	5.3935	3.4623	3.3989	5.2947	2.1819
12	250	5.6483	3.4793	3.5420	5.7501	2.1819
13	2	0.5574	3.0612	0.4977	0.0906	2.7331
14	5	1.3615	3.2202	1.1555	0.4886	2.7331
15	10	2.0087	3.3208	1.6532	1.0000	2.7331
16	25	2.9047	3.4351	2.3111	1.9542	2.7331
17	50	3.6082	3.5110	2.8088	2.8865	2.7331
18	75	4.0285	3.5519	3.0999	3.5159	2.7331
19	100	4.3304	3.5796	3.3064	4.0000	2.7331
20	125	4.5666	3.6003	3.4666	4.3970	2.7331
21	150	4.7608	3.6169	3.5975	4.7354	2.7331
22	175	4.9258	3.6305	3.7082	5.0312	2.7331
23	200	5.0694	3.6422	3.8041	5.2947	2.7331
24	250	5.3105	3.6612	3.9643	5.7501	2.7331
25	2	0.5273	3.1148	0.5353	0.0906	3.1618
26	5	1.2916	3.2859	1.2429	0.4886	3.1618
27	10	1.9087	3.3940	1.7782	1.0000	3.1618
28	25	2.7650	3.5170	2.4857	1.9542	3.1618
29	50	3.4383	3.5986	3.0210	2.8865	3.1618
30	75	3.8411	3.6426	3.3341	3.5159	3.1618
31	100	4.1305	3.6724	3.5563	4.0000	3.1618
32	125	4.3570	3.6947	3.7286	4.3970	3.1618
33	150	4.5433	3.7125	3.8694	4.7354	3.1618
34	175	4.7016	3.7272	3.9885	5.0312	3.1618
35	200	4.8394	3.7397	4.0916	5.2947	3.1618
36	250	5.0708	3.7602	4.2639	5.7501	3.1618
37	2	0.4849	3.1480	0.5883	0.0906	3.8191
38	5	1.1932	3.3360	1.3660	0.4886	3.8191
39	10	1.7678	3.4548	1.9542	1.0000	3.8191
40	25	2.5681	3.5900	2.7319	1.9542	3.8191
41	50	3.1990	3.6797	3.3202	2.8865	3.8191

42	75	3.5770	3.7280	3.6643	3.5159	3.8191
43	100	3.8488	3.7607	3.9085	4.0000	3.8191
44	125	4.0616	3.7853	4.0979	4.3970	3.8191
45	150	4.2367	3.8048	4.2526	4.7354	3.8191
46	175	4.3856	3.8210	4.3834	5.0312	3.8191
47	200	4.5152	3.8347	4.4968	5.2947	3.8191
48	250	4.7330	3.8573	4.6862	5.7501	3.8191
49	2	0.3590	2.9541	0.7457	0.0906	6.1361
50	5	0.9008	3.1924	1.7314	0.4886	6.1361
51	10	1.3495	3.3430	2.4771	1.0000	6.1361
52	25	1.9833	3.5144	3.4629	1.9542	6.1361
53	50	2.4883	3.6280	4.2086	2.8865	6.1361
54	75	2.7926	3.6893	4.6448	3.5159	6.1361
55	100	3.0122	3.7308	4.9542	4.0000	6.1361
56	125	3.1845	3.7619	5.1943	4.3970	6.1361
57	150	3.3265	3.7866	5.3904	4.7354	6.1361
58	175	3.4474	3.8071	5.5563	5.0312	6.1361
59	200	3.5527	3.8246	5.6999	5.2947	6.1361
60	250	3.7300	3.8531	5.9400	5.7501	6.1361
61	2	0.3098	2.7597	0.8071	0.0906	7.1891
62	5	0.7866	3.0176	1.8741	0.4886	7.1891
63	10	1.1862	3.1806	2.6812	1.0000	7.1891
64	25	1.7550	3.3661	3.7482	1.9542	7.1891
65	50	2.2109	3.4891	4.5553	2.8865	7.1891
66	75	2.4864	3.5555	5.0275	3.5159	7.1891
67	100	2.6856	3.6004	5.3625	4.0000	7.1891
68	125	2.8421	3.6340	5.6223	4.3970	7.1891
69	150	2.9711	3.6608	5.8346	4.7354	7.1891
70	175	3.0811	3.6830	6.0141	5.0312	7.1891
71	200	3.1770	3.7019	6.1696	5.2947	7.1891
72	250	3.3384	3.7328	6.4295	5.7501	7.1891
73	2	0.2674	2.5384	0.8601	0.0906	8.1643
74	5	0.6882	2.8132	1.9972	0.4886	8.1643
75	10	1.0454	2.9870	2.8573	1.0000	8.1643
76	25	1.5581	3.1847	3.9944	1.9542	8.1643
77	50	1.9715	3.3158	4.8545	2.8865	8.1643
78	75	2.2223	3.3865	5.3577	3.5159	8.1643
79	100	2.4039	3.4343	5.7147	4.0000	8.1643
80	125	2.5467	3.4702	5.9916	4.3970	8.1643
81	150	2.6646	3.4987	6.2178	4.7354	8.1643
82	175	2.7651	3.5224	6.4091	5.0312	8.1643
83	200	2.8528	3.5425	6.5748	5.2947	8.1643
84	250	3.0006	3.5754	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 145.383 $\quad \sum X_1 =$ 141.309

$\sum X_2 =$ 178.541 $\quad \sum Y * X_1 =$ 250.638

$\sum Y * X_2 =$ 292.099 $\quad \sum X_1 * X_2 =$ 300.350

$\sum X_1^{\,2} =$ 274.010 $\quad \sum X_2^{\,2} =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{\left(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}{\left(\sum (X_1 X_2) * \sum X_2 - \sum X_2^2 * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}$$

$C =$ -0.800000

$B =$ 0.1672094

$A =$ 3.14984889

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A =$ 1412.04613

$a = B =$ 0.1672094

$b = -C =$ 0.800000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

$\lambda =$ 1412.0

$\psi =$ 0.1672094

$\eta =$ 0.80

$\theta =$ 2.0

APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

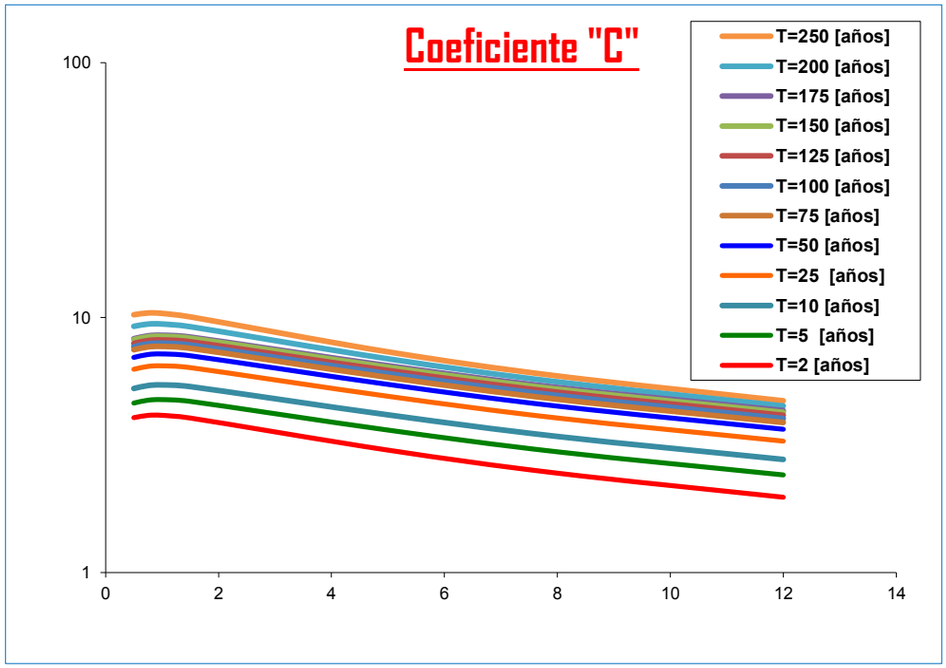
$$i = \frac{K * T_{\text{Re torno}}^{\ a}}{\left(D_{Duracion} + C\right)^{b}} \Leftrightarrow i = \frac{\lambda * T^{\psi}}{\left(d + \theta\right)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	4.05	4.13	4.14	4.04	3.02	2.45	1.97
5	4.62	4.74	4.77	4.69	3.62	2.97	2.41
10	5.27	5.41	5.44	5.36	4.15	3.42	2.78
25	6.27	6.43	6.47	6.36	4.91	4.04	3.28
50	6.98	7.16	7.20	7.09	5.47	4.49	3.65
75	7.48	7.67	7.71	7.58	5.83	4.78	3.88
100	7.69	7.89	7.93	7.81	6.03	4.95	4.02
125	7.92	8.13	8.17	8.04	6.21	5.10	4.14
150	8.20	8.41	8.45	8.30	6.39	5.24	4.25
175	8.26	8.48	8.52	8.39	6.48	5.32	4.32
200	9.24	9.43	9.44	9.21	6.89	5.60	4.50
250	10.26	10.42	10.38	10.06	7.34	5.90	4.72

Periodo (T)	C (Adoptado)
2	3.5
5	3.9
10	3.95
25	3.9
50	3.9
75	3.85
100	3.9
125	3.9
150	3.85
175	3.9
200	3.5
250	3.2



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} =$$ **3.7708**

$$\theta = \frac{\sum \theta_i}{K} =$$ 4.0

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X_1 = Log T	X_2 = Log D
1	2	32.40	30	1.5105	0.3010	1.4771
2	5	40.66	30	1.6092	0.6990	1.4771
3	10	46.91	30	1.6713	1.0000	1.4771
4	25	55.18	30	1.7417	1.3979	1.4771
5	50	61.43	30	1.7884	1.6990	1.4771
6	75	65.08	30	1.8135	1.8751	1.4771
7	100	67.68	30	1.8304	2.0000	1.4771
8	125	69.69	30	1.8432	2.0969	1.4771
9	150	71.33	30	1.8533	2.1761	1.4771
10	175	72.72	30	1.8617	2.2430	1.4771
11	200	73.93	30	1.8688	2.3010	1.4771
12	250	75.94	30	1.8805	2.3979	1.4771
13	2	23.42	45	1.3697	0.3010	1.6532
14	5	29.40	45	1.4683	0.6990	1.6532
15	10	33.92	45	1.5304	1.0000	1.6532
16	25	39.89	45	1.6009	1.3979	1.6532
17	50	44.41	45	1.6475	1.6990	1.6532
18	75	47.05	45	1.6726	1.8751	1.6532
19	100	48.93	45	1.6896	2.0000	1.6532
20	125	50.38	45	1.7023	2.0969	1.6532
21	150	51.57	45	1.7124	2.1761	1.6532
22	175	52.58	45	1.7208	2.2430	1.6532
23	200	53.45	45	1.7279	2.3010	1.6532
24	250	54.90	45	1.7396	2.3979	1.6532
25	2	18.61	60	1.2697	0.3010	1.7782
26	5	23.35	60	1.3684	0.6990	1.7782
27	10	26.94	60	1.4305	1.0000	1.7782
28	25	31.69	60	1.5009	1.3979	1.7782
29	50	35.28	60	1.5475	1.6990	1.7782
30	75	37.38	60	1.5726	1.8751	1.7782
31	100	38.87	60	1.5896	2.0000	1.7782
32	125	40.03	60	1.6023	2.0969	1.7782
33	150	40.97	60	1.6125	2.1761	1.7782
34	175	41.77	60	1.6208	2.2430	1.7782
35	200	42.46	60	1.6280	2.3010	1.7782
36	250	43.62	60	1.6396	2.3979	1.7782
37	2	13.45	90	1.1288	0.3010	1.9542
38	5	16.88	90	1.2275	0.6990	1.9542
39	10	19.48	90	1.2896	1.0000	1.9542
40	25	22.91	90	1.3600	1.3979	1.9542
41	50	25.51	90	1.4067	1.6990	1.9542

42	75	27.03	90	1.4318	1.8751	1.9542
43	100	28.10	90	1.4487	2.0000	1.9542
44	125	28.94	90	1.4615	2.0969	1.9542
45	150	29.62	90	1.4716	2.1761	1.9542
46	175	30.20	90	1.4800	2.2430	1.9542
47	200	30.70	90	1.4871	2.3010	1.9542
48	250	31.53	90	1.4988	2.3979	1.9542
49	2	5.13	300	0.7105	0.3010	2.4771
50	5	6.44	300	0.8092	0.6990	2.4771
51	10	7.44	300	0.8713	1.0000	2.4771
52	25	8.74	300	0.9417	1.3979	2.4771
53	50	9.74	300	0.9884	1.6990	2.4771
54	75	10.31	300	1.0135	1.8751	2.4771
55	100	10.73	300	1.0304	2.0000	2.4771
56	125	11.04	300	1.0432	2.0969	2.4771
57	150	11.31	300	1.0533	2.1761	2.4771
58	175	11.53	300	1.0617	2.2430	2.4771
59	200	11.72	300	1.0688	2.3010	2.4771
60	250	12.04	300	1.0805	2.3979	2.4771
61	2	3.53	480	0.5472	0.3010	2.6812
62	5	4.42	480	0.6459	0.6990	2.6812
63	10	5.10	480	0.7080	1.0000	2.6812
64	25	6.00	480	0.7784	1.3979	2.6812
65	50	6.68	480	0.8251	1.6990	2.6812
66	75	7.08	480	0.8502	1.8751	2.6812
67	100	7.36	480	0.8671	2.0000	2.6812
68	125	7.58	480	0.8799	2.0969	2.6812
69	150	7.76	480	0.8900	2.1761	2.6812
70	175	7.91	480	0.8984	2.2430	2.6812
71	200	8.04	480	0.9055	2.3010	2.6812
72	250	8.26	480	0.9172	2.3979	2.6812
73	2	2.55	720	0.4064	0.3010	2.8573
74	5	3.20	720	0.5050	0.6990	2.8573
75	10	3.69	720	0.5671	1.0000	2.8573
76	25	4.34	720	0.6376	1.3979	2.8573
77	50	4.83	720	0.6842	1.6990	2.8573
78	75	5.12	720	0.7093	1.8751	2.8573
79	100	5.32	720	0.7263	2.0000	2.8573
80	125	5.48	720	0.7390	2.0969	2.8573
81	150	5.61	720	0.7491	2.1761	2.8573
82	175	5.72	720	0.7575	2.2430	2.8573
83	200	5.82	720	0.7646	2.3010	2.8573
84	250	5.97	720	0.7763	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	$Y*X_1$	$Y*X_2$	X_1*X_2	X_1^2	X_2^2
1	2	0.4547	2.2312	0.4447	0.0906	2.1819
2	5	1.1248	2.3770	1.0325	0.4886	2.1819
3	10	1.6713	2.4687	1.4771	1.0000	2.1819

4	25	2.4349	2.5728	2.0649	1.9542	2.1819
5	50	3.0384	2.6416	2.5096	2.8865	2.1819
6	75	3.4004	2.6787	2.7697	3.5159	2.1819
7	100	3.6609	2.7038	2.9542	4.0000	2.1819
8	125	3.8649	2.7226	3.0974	4.3970	2.1819
9	150	4.0329	2.7375	3.2144	4.7354	2.1819
10	175	4.1758	2.7499	3.3132	5.0312	2.1819
11	200	4.3002	2.7605	3.3989	5.2947	2.1819
12	250	4.5093	2.7777	3.5420	5.7501	2.1819
13	2	0.4123	2.2643	0.4977	0.0906	2.7331
14	5	1.0263	2.4274	1.1555	0.4886	2.7331
15	10	1.5304	2.5301	1.6532	1.0000	2.7331
16	25	2.2379	2.6466	2.3111	1.9542	2.7331
17	50	2.7990	2.7236	2.8088	2.8865	2.7331
18	75	3.1362	2.7651	3.0999	3.5159	2.7331
19	100	3.3791	2.7932	3.3064	4.0000	2.7331
20	125	3.5696	2.8142	3.4666	4.3970	2.7331
21	150	3.7264	2.8310	3.5975	4.7354	2.7331
22	175	3.8598	2.8448	3.7082	5.0312	2.7331
23	200	3.9760	2.8566	3.8041	5.2947	2.7331
24	250	4.1714	2.8759	3.9643	5.7501	2.7331
25	2	0.3822	2.2577	0.5353	0.0906	3.1618
26	5	0.9564	2.4332	1.2429	0.4886	3.1618
27	10	1.4305	2.5436	1.7782	1.0000	3.1618
28	25	2.0982	2.6689	2.4857	1.9542	3.1618
29	50	2.6292	2.7517	3.0210	2.8865	3.1618
30	75	2.9488	2.7964	3.3341	3.5159	3.1618
31	100	3.1792	2.8266	3.5563	4.0000	3.1618
32	125	3.3600	2.8492	3.7286	4.3970	3.1618
33	150	3.5089	2.8672	3.8694	4.7354	3.1618
34	175	3.6356	2.8821	3.9885	5.0312	3.1618
35	200	3.7460	2.8948	4.0916	5.2947	3.1618
36	250	3.9318	2.9155	4.2639	5.7501	3.1618
37	2	0.3398	2.2060	0.5883	0.0906	3.8191
38	5	0.8580	2.3988	1.3660	0.4886	3.8191
39	10	1.2896	2.5202	1.9542	1.0000	3.8191
40	25	1.9013	2.6579	2.7319	1.9542	3.8191
41	50	2.3899	2.7489	3.3202	2.8865	3.8191
42	75	2.6847	2.7980	3.6643	3.5159	3.8191
43	100	2.8975	2.8312	3.9085	4.0000	3.8191
44	125	3.0646	2.8561	4.0979	4.3970	3.8191
45	150	3.2023	2.8759	4.2526	4.7354	3.8191
46	175	3.3196	2.8922	4.3834	5.0312	3.8191
47	200	3.4219	2.9062	4.4968	5.2947	3.8191
48	250	3.5940	2.9290	4.6862	5.7501	3.8191
49	2	0.2139	1.7601	0.7457	0.0906	6.1361
50	5	0.5656	2.0045	1.7314	0.4886	6.1361
51	10	0.8713	2.1583	2.4771	1.0000	6.1361
52	25	1.3165	2.3328	3.4629	1.9542	6.1361
53	50	1.6792	2.4483	4.2086	2.8865	6.1361

54	75	1.9003	2.5105	4.6448	3.5159	6.1361
55	100	2.0609	2.5525	4.9542	4.0000	6.1361
56	125	2.1874	2.5840	5.1943	4.3970	6.1361
57	150	2.2921	2.6091	5.3904	4.7354	6.1361
58	175	2.3814	2.6299	5.5563	5.0312	6.1361
59	200	2.4594	2.6476	5.6999	5.2947	6.1361
60	250	2.5909	2.6765	5.9400	5.7501	6.1361
61	2	0.1647	1.4673	0.8071	0.0906	7.1891
62	5	0.4515	1.7318	1.8741	0.4886	7.1891
63	10	0.7080	1.8983	2.6812	1.0000	7.1891
64	25	1.0882	2.0872	3.7482	1.9542	7.1891
65	50	1.4017	2.2122	4.5553	2.8865	7.1891
66	75	1.5941	2.2795	5.0275	3.5159	7.1891
67	100	1.7343	2.3250	5.3625	4.0000	7.1891
68	125	1.8450	2.3591	5.6223	4.3970	7.1891
69	150	1.9367	2.3863	5.8346	4.7354	7.1891
70	175	2.0151	2.4088	6.0141	5.0312	7.1891
71	200	2.0836	2.4279	6.1696	5.2947	7.1891
72	250	2.1993	2.4592	6.4295	5.7501	7.1891
73	2	0.1223	1.1611	0.8601	0.0906	8.1643
74	5	0.3530	1.4430	1.9972	0.4886	8.1643
75	10	0.5671	1.6204	2.8573	1.0000	8.1643
76	25	0.8913	1.8218	3.9944	1.9542	8.1643
77	50	1.1624	1.9549	4.8545	2.8865	8.1643
78	75	1.3300	2.0267	5.3577	3.5159	8.1643
79	100	1.4525	2.0752	5.7147	4.0000	8.1643
80	125	1.5496	2.1116	5.9916	4.3970	8.1643
81	150	1.6302	2.1405	6.2178	4.7354	8.1643
82	175	1.6991	2.1644	6.4091	5.0312	8.1643
83	200	1.7595	2.1848	6.5748	5.2947	8.1643
84	250	1.8615	2.2181	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 105.337

$\sum X_1 =$ 141.309

$\sum X_2 =$ 178.541

$\sum Y * X_1 =$ 183.382

$\sum Y * X_2 =$ 206.981

$\sum X_1 * X_2 =$ 300.350

$\sum X_1^2 =$ 274.010

$\sum X_2^2 =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{\left(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^{\,2} * n\right) - \left(\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2\right) * \left(\sum X_1^{\,2} * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}{\left(\left(\sum (X_1 X_2) * \sum X_2 - \sum X_2^{\,2} * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^{\,2} * n\right)\right) - \left(\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n\right) * \left(\sum X_1^{\,2} * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}$$

C = -0.800000

B = 0.1702806

A = 2.66794340

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A$ = 465.525423

$a = B$ = 0.1702806

$b = -C$ = 0.800000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

λ = 465.5

ψ = 0.1702806

η = 0.80

θ = 4.0

APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

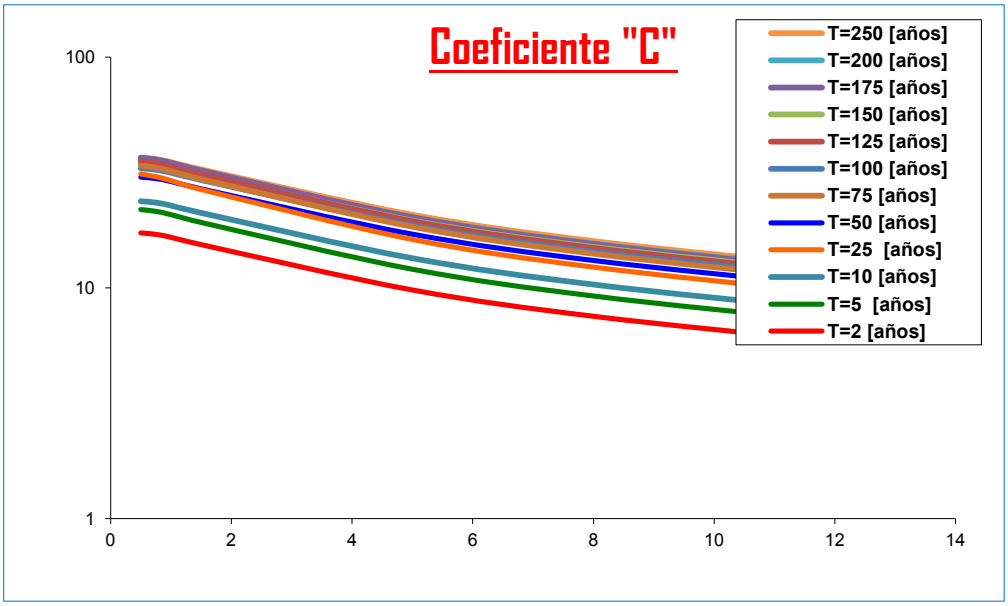
$$i = \frac{K * T_{\text{Re torno}}^{\ a}}{(D_{Duracion} + C)^b} \Longleftrightarrow i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	17.31	17.07	16.57	15.41	9.80	7.54	5.84
5	21.86	21.47	20.78	19.22	12.05	9.23	7.13
10	23.77	23.43	22.75	21.15	13.45	10.34	8.01
25	31.18	30.36	29.18	26.70	16.23	12.31	9.45
50	30.22	29.79	28.92	26.89	17.10	13.15	10.19
75	33.87	33.20	32.08	29.60	18.42	14.07	10.85
100	32.99	32.53	31.58	29.36	18.68	14.36	11.12
125	35.30	34.67	33.56	31.04	19.46	14.90	11.51
150	34.62	34.13	33.14	30.81	19.60	15.07	11.67
175	36.71	36.05	34.89	32.28	20.23	15.49	11.97
200	35.77	35.27	34.24	31.83	20.25	15.57	12.06
250	36.67	36.15	35.10	32.63	20.75	15.96	12.36

Periodo (T)	C (Adoptado)
2	2
5	1.9
10	2
25	1.7
50	2
75	1.85
100	2
125	1.9
150	2
175	1.9
200	2
250	2



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} =$$ 1.9375 $$\theta = \frac{\sum \theta_i}{K} =$$ 2.0

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X1 = Log T	X2 = Log D
1	2	86.57	30	1.9374	0.3010	1.4771
2	5	104.93	30	2.0209	0.6990	1.4771
3	10	118.83	30	2.0749	1.0000	1.4771
4	25	137.19	30	2.1373	1.3979	1.4771
5	50	151.08	30	2.1792	1.6990	1.4771
6	75	159.21	30	2.2020	1.8751	1.4771
7	100	164.97	30	2.2174	2.0000	1.4771
8	125	169.45	30	2.2290	2.0969	1.4771
9	150	173.10	30	2.2383	2.1761	1.4771
10	175	176.19	30	2.2460	2.2430	1.4771
11	200	178.86	30	2.2525	2.3010	1.4771
12	250	183.34	30	2.2633	2.3979	1.4771
13	2	62.59	45	1.7965	0.3010	1.6532
14	5	75.87	45	1.8800	0.6990	1.6532
15	10	85.91	45	1.9340	1.0000	1.6532
16	25	99.19	45	1.9964	1.3979	1.6532
17	50	109.23	45	2.0383	1.6990	1.6532
18	75	115.10	45	2.0611	1.8751	1.6532
19	100	119.27	45	2.0765	2.0000	1.6532
20	125	122.51	45	2.0882	2.0969	1.6532
21	150	125.15	45	2.0974	2.1761	1.6532
22	175	127.38	45	2.1051	2.2430	1.6532
23	200	129.32	45	2.1117	2.3010	1.6532
24	250	132.55	45	2.1224	2.3979	1.6532
25	2	49.72	60	1.6965	0.3010	1.7782
26	5	60.27	60	1.7801	0.6990	1.7782
27	10	68.25	60	1.8341	1.0000	1.7782
28	25	78.79	60	1.8965	1.3979	1.7782
29	50	86.77	60	1.9384	1.6990	1.7782
30	75	91.44	60	1.9611	1.8751	1.7782
31	100	94.75	60	1.9766	2.0000	1.7782
32	125	97.32	60	1.9882	2.0969	1.7782
33	150	99.42	60	1.9975	2.1761	1.7782
34	175	101.19	60	2.0052	2.2430	1.7782

35	200	102.73	60	2.0117	2.3010	1.7782
36	250	105.30	60	2.0224	2.3979	1.7782
37	2	35.95	90	1.5557	0.3010	1.9542
38	5	43.57	90	1.6392	0.6990	1.9542
39	10	49.34	90	1.6932	1.0000	1.9542
40	25	56.97	90	1.7556	1.3979	1.9542
41	50	62.74	90	1.7975	1.6990	1.9542
42	75	66.11	90	1.8203	1.8751	1.9542
43	100	68.50	90	1.8357	2.0000	1.9542
44	125	70.36	90	1.8473	2.0969	1.9542
45	150	71.88	90	1.8566	2.1761	1.9542
46	175	73.16	90	1.8643	2.2430	1.9542
47	200	74.27	90	1.8708	2.3010	1.9542
48	250	76.13	90	1.8816	2.3979	1.9542
49	2	13.72	300	1.1374	0.3010	2.4771
50	5	16.63	300	1.2209	0.6990	2.4771
51	10	18.83	300	1.2749	1.0000	2.4771
52	25	21.74	300	1.3373	1.3979	2.4771
53	50	23.94	300	1.3792	1.6990	2.4771
54	75	25.23	300	1.4020	1.8751	2.4771
55	100	26.15	300	1.4174	2.0000	2.4771
56	125	26.86	300	1.4290	2.0969	2.4771
57	150	27.43	300	1.4383	2.1761	2.4771
58	175	27.92	300	1.4460	2.2430	2.4771
59	200	28.35	300	1.4525	2.3010	2.4771
60	250	29.06	300	1.4633	2.3979	2.4771
61	2	9.42	480	0.9741	0.3010	2.6812
62	5	11.42	480	1.0576	0.6990	2.6812
63	10	12.93	480	1.1116	1.0000	2.6812
64	25	14.93	480	1.1740	1.3979	2.6812
65	50	16.44	480	1.2159	1.6990	2.6812
66	75	17.32	480	1.2387	1.8751	2.6812
67	100	17.95	480	1.2541	2.0000	2.6812
68	125	18.44	480	1.2657	2.0969	2.6812
69	150	18.84	480	1.2750	2.1761	2.6812
70	175	19.17	480	1.2827	2.2430	2.6812
71	200	19.46	480	1.2892	2.3010	2.6812
72	250	19.95	480	1.3000	2.3979	2.6812
73	2	6.81	720	0.8332	0.3010	2.8573
74	5	8.26	720	0.9167	0.6990	2.8573
75	10	9.35	720	0.9707	1.0000	2.8573
76	25	10.79	720	1.0332	1.3979	2.8573
77	50	11.89	720	1.0750	1.6990	2.8573
78	75	12.53	720	1.0978	1.8751	2.8573
79	100	12.98	720	1.1132	2.0000	2.8573
80	125	13.33	720	1.1249	2.0969	2.8573
81	150	13.62	720	1.1341	2.1761	2.8573

82	175	13.86	720	1.1418	2.2430	2.8573
83	200	14.07	720	1.1484	2.3010	2.8573
84	250	14.42	720	1.1591	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	$Y*X_1$	$Y*X_2$	X_1*X_2	X_1^2	X_2^2
1	2	0.5832	2.8617	0.4447	0.0906	2.1819
2	5	1.4126	2.9851	1.0325	0.4886	2.1819
3	10	2.0749	3.0649	1.4771	1.0000	2.1819
4	25	2.9878	3.1571	2.0649	1.9542	2.1819
5	50	3.7024	3.2190	2.5096	2.8865	2.1819
6	75	4.1288	3.2526	2.7697	3.5159	2.1819
7	100	4.4348	3.2754	2.9542	4.0000	2.1819
8	125	4.6741	3.2925	3.0974	4.3970	2.1819
9	150	4.8707	3.3062	3.2144	4.7354	2.1819
10	175	5.0378	3.3176	3.3132	5.0312	2.1819
11	200	5.1831	3.3273	3.3989	5.2947	2.1819
12	250	5.4271	3.3431	3.5420	5.7501	2.1819
13	2	0.5408	2.9700	0.4977	0.0906	2.7331
14	5	1.3141	3.1081	1.1555	0.4886	2.7331
15	10	1.9340	3.1974	1.6532	1.0000	2.7331
16	25	2.7909	3.3006	2.3111	1.9542	2.7331
17	50	3.4631	3.3698	2.8088	2.8865	2.7331
18	75	3.8647	3.4074	3.0999	3.5159	2.7331
19	100	4.1531	3.4330	3.3064	4.0000	2.7331
20	125	4.3787	3.4522	3.4666	4.3970	2.7331
21	150	4.5642	3.4675	3.5975	4.7354	2.7331
22	175	4.7218	3.4802	3.7082	5.0312	2.7331
23	200	4.8590	3.4910	3.8041	5.2947	2.7331
24	250	5.0893	3.5087	3.9643	5.7501	2.7331
25	2	0.5107	3.0167	0.5353	0.0906	3.1618
26	5	1.2442	3.1653	1.2429	0.4886	3.1618
27	10	1.8341	3.2613	1.7782	1.0000	3.1618
28	25	2.6512	3.3723	2.4857	1.9542	3.1618
29	50	3.2933	3.4467	3.0210	2.8865	3.1618
30	75	3.6773	3.4872	3.3341	3.5159	3.1618
31	100	3.9532	3.5147	3.5563	4.0000	3.1618
32	125	4.1691	3.5353	3.7286	4.3970	3.1618
33	150	4.3467	3.5518	3.8694	4.7354	3.1618
34	175	4.4976	3.5655	3.9885	5.0312	3.1618
35	200	4.6290	3.5771	4.0916	5.2947	3.1618
36	250	4.8497	3.5962	4.2639	5.7501	3.1618
37	2	0.4683	3.0402	0.5883	0.0906	3.8191
38	5	1.1458	3.2034	1.3660	0.4886	3.8191
39	10	1.6932	3.3090	1.9542	1.0000	3.8191

40	25	2.4543	3.4309	2.7319	1.9542	3.8191
41	50	3.0539	3.5128	3.3202	2.8865	3.8191
42	75	3.4131	3.5572	3.6643	3.5159	3.8191
43	100	3.6714	3.5874	3.9085	4.0000	3.8191
44	125	3.8737	3.6101	4.0979	4.3970	3.8191
45	150	4.0401	3.6282	4.2526	4.7354	3.8191
46	175	4.1817	3.6433	4.3834	5.0312	3.8191
47	200	4.3048	3.6561	4.4968	5.2947	3.8191
48	250	4.5119	3.6770	4.6862	5.7501	3.8191
49	2	0.3424	2.8174	0.7457	0.0906	6.1361
50	5	0.8534	3.0244	1.7314	0.4886	6.1361
51	10	1.2749	3.1581	2.4771	1.0000	6.1361
52	25	1.8695	3.3127	3.4629	1.9542	6.1361
53	50	2.3432	3.4165	4.2086	2.8865	6.1361
54	75	2.6288	3.4728	4.6448	3.5159	6.1361
55	100	2.8348	3.5111	4.9542	4.0000	6.1361
56	125	2.9965	3.5399	5.1943	4.3970	6.1361
57	150	3.1299	3.5628	5.3904	4.7354	6.1361
58	175	3.2434	3.5819	5.5563	5.0312	6.1361
59	200	3.3423	3.5981	5.6999	5.2947	6.1361
60	250	3.5088	3.6246	5.9400	5.7501	6.1361
61	2	0.2932	2.6117	0.8071	0.0906	7.1891
62	5	0.7392	2.8357	1.8741	0.4886	7.1891
63	10	1.1116	2.9805	2.6812	1.0000	7.1891
64	25	1.6412	3.1478	3.7482	1.9542	7.1891
65	50	2.0658	3.2602	4.5553	2.8865	7.1891
66	75	2.3226	3.3212	5.0275	3.5159	7.1891
67	100	2.5082	3.3626	5.3625	4.0000	7.1891
68	125	2.6541	3.3937	5.6223	4.3970	7.1891
69	150	2.7745	3.4186	5.8346	4.7354	7.1891
70	175	2.8771	3.4392	6.0141	5.0312	7.1891
71	200	2.9666	3.4567	6.1696	5.2947	7.1891
72	250	3.1172	3.4855	6.4295	5.7501	7.1891
73	2	0.2508	2.3807	0.8601	0.0906	8.1643
74	5	0.6408	2.6195	1.9972	0.4886	8.1643
75	10	0.9707	2.7737	2.8573	1.0000	8.1643
76	25	1.4443	2.9521	3.9944	1.9542	8.1643
77	50	1.8265	3.0718	4.8545	2.8865	8.1643
78	75	2.0584	3.1368	5.3577	3.5159	8.1643
79	100	2.2265	3.1809	5.7147	4.0000	8.1643
80	125	2.3587	3.2141	5.9916	4.3970	8.1643
81	150	2.4680	3.2406	6.2178	4.7354	8.1643
82	175	2.5611	3.2625	6.4091	5.0312	8.1643
83	200	2.6424	3.2812	6.5748	5.2947	8.1643
84	250	2.7794	3.3119	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 138.417 $\quad \sum X_1 =$ 141.309

$\sum X_2 =$ 178.541 $\quad \sum Y * X_1 =$ 238.326

$\sum Y * X_2 =$ 277.293 $\quad \sum X_1 * X_2 =$ 300.350

$\sum X_1^{\,2} =$ 274.010 $\quad \sum X_2^{\,2} =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{\left(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}{\left(\sum (X_1 X_2) * \sum X_2 - \sum X_2^2 * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}$$

$C =$ -0.800000

$B =$ 0.1508399

$A =$ 3.09446272

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A =$ 1242.97593

$a = B =$ 0.1508399

$b = -C =$ 0.800000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

$\lambda =$ 1243.0

$\psi =$ 0.1508399

$\eta =$ 0.80

$\theta =$ 2.0

APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

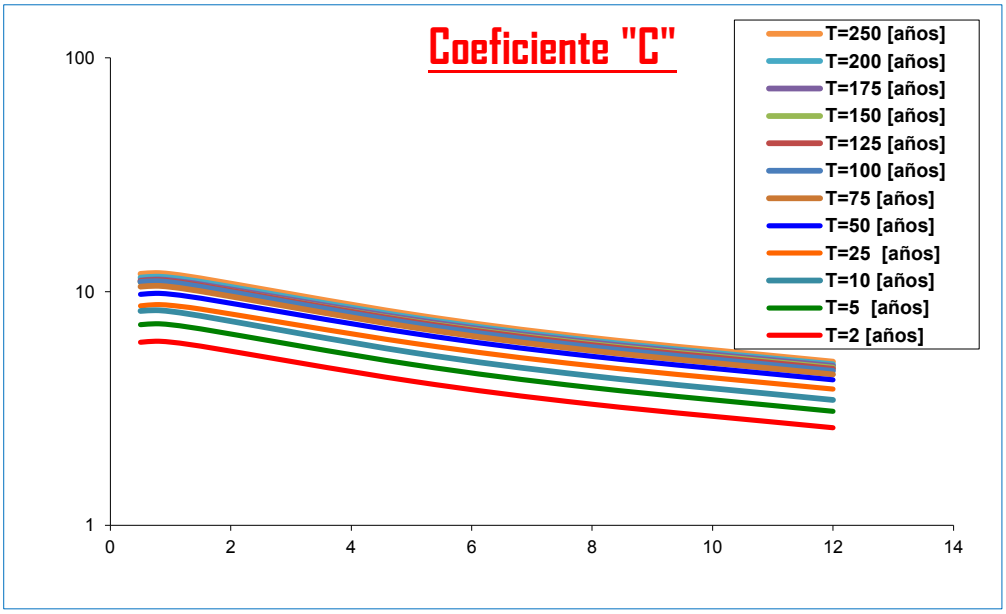
$$i = \frac{K * T_{\text{Re torno}}^{\ a}}{(D_{Duracion} + C)^b} \Longleftrightarrow i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	6.07	6.13	6.08	5.84	4.14	3.30	2.62
5	7.22	7.28	7.21	6.92	4.88	3.88	3.07
10	8.26	8.32	8.23	7.87	5.49	4.35	3.44
25	8.69	8.79	8.73	8.42	6.02	4.81	3.83
50	9.73	9.83	9.74	9.37	6.64	5.28	4.19
75	10.50	10.59	10.47	10.04	7.04	5.59	4.42
100	11.00	11.08	10.96	10.48	7.31	5.79	4.58
125	11.10	11.19	11.07	10.61	7.44	5.90	4.67
150	10.98	11.09	11.00	10.57	7.49	5.96	4.73
175	11.16	11.27	11.17	10.74	7.61	6.06	4.81
200	11.48	11.58	11.47	11.01	7.76	6.17	4.89
250	11.91	12.01	11.88	11.39	7.99	6.34	5.01

Periodo (T)	C (Adoptado)
2	2.9
5	2.85
10	2.75
25	3
50	2.9
75	2.8
100	2.75
125	2.8
150	2.9
175	2.9
200	2.85
250	2.8



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} = 2.8500 \qquad \theta = \frac{\sum \theta_i}{K} = 3.0$$

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X1 = Log T	X2 = Log D
1	2	41.27	30	1.6157	0.3010	1.4771
2	5	48.36	30	1.6845	0.6990	1.4771
3	10	53.72	30	1.7301	1.0000	1.4771
4	25	60.81	30	1.7840	1.3979	1.4771
5	50	66.17	30	1.8207	1.6990	1.4771
6	75	69.30	30	1.8408	1.8751	1.4771
7	100	71.53	30	1.8545	2.0000	1.4771
8	125	73.25	30	1.8648	2.0969	1.4771
9	150	74.66	30	1.8731	2.1761	1.4771
10	175	75.86	30	1.8800	2.2430	1.4771
11	200	76.89	30	1.8859	2.3010	1.4771
12	250	78.62	30	1.8955	2.3979	1.4771
13	2	29.84	45	1.4748	0.3010	1.6532
14	5	34.96	45	1.5436	0.6990	1.6532
15	10	38.84	45	1.5893	1.0000	1.6532
16	25	43.96	45	1.6431	1.3979	1.6532
17	50	47.84	45	1.6798	1.6990	1.6532
18	75	50.11	45	1.6999	1.8751	1.6532
19	100	51.71	45	1.7136	2.0000	1.6532
20	125	52.96	45	1.7240	2.0969	1.6532
21	150	53.98	45	1.7322	2.1761	1.6532
22	175	54.84	45	1.7391	2.2430	1.6532
23	200	55.59	45	1.7450	2.3010	1.6532
24	250	56.84	45	1.7546	2.3979	1.6532
25	2	23.71	60	1.3749	0.3010	1.7782
26	5	27.78	60	1.4437	0.6990	1.7782
27	10	30.85	60	1.4893	1.0000	1.7782
28	25	34.92	60	1.5431	1.3979	1.7782
29	50	38.00	60	1.5798	1.6990	1.7782
30	75	39.80	60	1.5999	1.8751	1.7782
31	100	41.08	60	1.6137	2.0000	1.7782
32	125	42.07	60	1.6240	2.0969	1.7782
33	150	42.88	60	1.6323	2.1761	1.7782
34	175	43.57	60	1.6392	2.2430	1.7782
35	200	44.16	60	1.6450	2.3010	1.7782
36	250	45.15	60	1.6547	2.3979	1.7782

37	2	17.14	90	1.2340	0.3010	1.9542
38	5	20.08	90	1.3028	0.6990	1.9542
39	10	22.31	90	1.3485	1.0000	1.9542
40	25	25.25	90	1.4023	1.3979	1.9542
41	50	27.48	90	1.4390	1.6990	1.9542
42	75	28.78	90	1.4591	1.8751	1.9542
43	100	29.70	90	1.4728	2.0000	1.9542
44	125	30.42	90	1.4831	2.0969	1.9542
45	150	31.00	90	1.4914	2.1761	1.9542
46	175	31.50	90	1.4983	2.2430	1.9542
47	200	31.93	90	1.5042	2.3010	1.9542
48	250	32.64	90	1.5138	2.3979	1.9542
49	2	6.54	300	0.8157	0.3010	2.4771
50	5	7.66	300	0.8845	0.6990	2.4771
51	10	8.51	300	0.9301	1.0000	2.4771
52	25	9.64	300	0.9840	1.3979	2.4771
53	50	10.49	300	1.0207	1.6990	2.4771
54	75	10.98	300	1.0408	1.8751	2.4771
55	100	11.34	300	1.0545	2.0000	2.4771
56	125	11.61	300	1.0648	2.0969	2.4771
57	150	11.83	300	1.0731	2.1761	2.4771
58	175	12.02	300	1.0800	2.2430	2.4771
59	200	12.19	300	1.0859	2.3010	2.4771
60	250	12.46	300	1.0955	2.3979	2.4771
61	2	4.49	480	0.6524	0.3010	2.6812
62	5	5.26	480	0.7212	0.6990	2.6812
63	10	5.85	480	0.7669	1.0000	2.6812
64	25	6.62	480	0.8207	1.3979	2.6812
65	50	7.20	480	0.8574	1.6990	2.6812
66	75	7.54	480	0.8775	1.8751	2.6812
67	100	7.78	480	0.8912	2.0000	2.6812
68	125	7.97	480	0.9015	2.0969	2.6812
69	150	8.12	480	0.9098	2.1761	2.6812
70	175	8.25	480	0.9167	2.2430	2.6812
71	200	8.37	480	0.9226	2.3010	2.6812
72	250	8.55	480	0.9322	2.3979	2.6812
73	2	3.25	720	0.5115	0.3010	2.8573
74	5	3.80	720	0.5803	0.6990	2.8573
75	10	4.23	720	0.6260	1.0000	2.8573
76	25	4.78	720	0.6798	1.3979	2.8573
77	50	5.21	720	0.7165	1.6990	2.8573
78	75	5.45	720	0.7366	1.8751	2.8573
79	100	5.63	720	0.7503	2.0000	2.8573
80	125	5.76	720	0.7607	2.0969	2.8573
81	150	5.87	720	0.7689	2.1761	2.8573
82	175	5.97	720	0.7758	2.2430	2.8573
83	200	6.05	720	0.7817	2.3010	2.8573

84	250	6.19	720	0.7913	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	Y*X1	Y*X2	X1*X2	X1^2	X2^2
1	2	0.4864	2.3866	0.4447	0.0906	2.1819
2	5	1.1774	2.4882	1.0325	0.4886	2.1819
3	10	1.7301	2.5556	1.4771	1.0000	2.1819
4	25	2.4939	2.6351	2.0649	1.9542	2.1819
5	50	3.0932	2.6893	2.5096	2.8865	2.1819
6	75	3.4515	2.7190	2.7697	3.5159	2.1819
7	100	3.7090	2.7393	2.9542	4.0000	2.1819
8	125	3.9104	2.7546	3.0974	4.3970	2.1819
9	150	4.0761	2.7668	3.2144	4.7354	2.1819
10	175	4.2169	2.7770	3.3132	5.0312	2.1819
11	200	4.3394	2.7857	3.3989	5.2947	2.1819
12	250	4.5453	2.7999	3.5420	5.7501	2.1819
13	2	0.4440	2.4382	0.4977	0.0906	2.7331
14	5	1.0789	2.5519	1.1555	0.4886	2.7331
15	10	1.5893	2.6274	1.6532	1.0000	2.7331
16	25	2.2969	2.7164	2.3111	1.9542	2.7331
17	50	2.8539	2.7770	2.8088	2.8865	2.7331
18	75	3.1874	2.8103	3.0999	3.5159	2.7331
19	100	3.4272	2.8330	3.3064	4.0000	2.7331
20	125	3.6150	2.8501	3.4666	4.3970	2.7331
21	150	3.7695	2.8638	3.5975	4.7354	2.7331
22	175	3.9009	2.8751	3.7082	5.0312	2.7331
23	200	4.0153	2.8848	3.8041	5.2947	2.7331
24	250	4.2075	2.9008	3.9643	5.7501	2.7331
25	2	0.4139	2.4447	0.5353	0.0906	3.1618
26	5	1.0091	2.5671	1.2429	0.4886	3.1618
27	10	1.4893	2.6482	1.7782	1.0000	3.1618
28	25	2.1572	2.7439	2.4857	1.9542	3.1618
29	50	2.6841	2.8092	3.0210	2.8865	3.1618
30	75	3.0000	2.8449	3.3341	3.5159	3.1618
31	100	3.2273	2.8693	3.5563	4.0000	3.1618
32	125	3.4054	2.8877	3.7286	4.3970	3.1618
33	150	3.5520	2.9025	3.8694	4.7354	3.1618
34	175	3.6767	2.9147	3.9885	5.0312	3.1618
35	200	3.7853	2.9251	4.0916	5.2947	3.1618
36	250	3.9678	2.9423	4.2639	5.7501	3.1618
37	2	0.3715	2.4115	0.5883	0.0906	3.8191
38	5	0.9106	2.5460	1.3660	0.4886	3.8191
39	10	1.3485	2.6352	1.9542	1.0000	3.8191
40	25	1.9603	2.7404	2.7319	1.9542	3.8191
41	50	2.4447	2.8121	3.3202	2.8865	3.8191

42	75	2.7358	2.8514	3.6643	3.5159	3.8191
43	100	2.9456	2.8782	3.9085	4.0000	3.8191
44	125	3.1100	2.8984	4.0979	4.3970	3.8191
45	150	3.2455	2.9146	4.2526	4.7354	3.8191
46	175	3.3607	2.9280	4.3834	5.0312	3.8191
47	200	3.4611	2.9395	4.4968	5.2947	3.8191
48	250	3.6300	2.9584	4.6862	5.7501	3.8191
49	2	0.2455	2.0205	0.7457	0.0906	6.1361
50	5	0.6182	2.1910	1.7314	0.4886	6.1361
51	10	0.9301	2.3041	2.4771	1.0000	6.1361
52	25	1.3755	2.4374	3.4629	1.9542	6.1361
53	50	1.7341	2.5283	4.2086	2.8865	6.1361
54	75	1.9515	2.5781	4.6448	3.5159	6.1361
55	100	2.1090	2.6121	4.9542	4.0000	6.1361
56	125	2.2329	2.6377	5.1943	4.3970	6.1361
57	150	2.3352	2.6582	5.3904	4.7354	6.1361
58	175	2.4225	2.6753	5.5563	5.0312	6.1361
59	200	2.4986	2.6898	5.6999	5.2947	6.1361
60	250	2.6270	2.7137	5.9400	5.7501	6.1361
61	2	0.1964	1.7492	0.8071	0.0906	7.1891
62	5	0.5041	1.9337	1.8741	0.4886	7.1891
63	10	0.7669	2.0561	2.6812	1.0000	7.1891
64	25	1.1472	2.2004	3.7482	1.9542	7.1891
65	50	1.4566	2.2988	4.5553	2.8865	7.1891
66	75	1.6453	2.3527	5.0275	3.5159	7.1891
67	100	1.7824	2.3895	5.3625	4.0000	7.1891
68	125	1.8905	2.4172	5.6223	4.3970	7.1891
69	150	1.9799	2.4394	5.8346	4.7354	7.1891
70	175	2.0562	2.4579	6.0141	5.0312	7.1891
71	200	2.1229	2.4736	6.1696	5.2947	7.1891
72	250	2.2354	2.4995	6.4295	5.7501	7.1891
73	2	0.1540	1.4616	0.8601	0.0906	8.1643
74	5	0.4056	1.6582	1.9972	0.4886	8.1643
75	10	0.6260	1.7886	2.8573	1.0000	8.1643
76	25	0.9503	1.9424	3.9944	1.9542	8.1643
77	50	1.2173	2.0472	4.8545	2.8865	8.1643
78	75	1.3812	2.1047	5.3577	3.5159	8.1643
79	100	1.5006	2.1439	5.7147	4.0000	8.1643
80	125	1.5951	2.1735	5.9916	4.3970	8.1643
81	150	1.6733	2.1971	6.2178	4.7354	8.1643
82	175	1.7402	2.2168	6.4091	5.0312	8.1643
83	200	1.7987	2.2336	6.5748	5.2947	8.1643
84	250	1.8976	2.2611	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 108.536 $\quad \sum X_1 =$ 141.309

$\sum X_2 =$ 178.541 $\quad \sum Y * X_1 =$ 187.312

$\sum Y * X_2 =$ 213.782 $\quad \sum X_1 * X_2 =$ 300.350

$\sum X_1^{\,2} =$ 274.010 $\quad \sum X_2^{\,2} =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{\left(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}{\left(\sum (X_1 X_2) * \sum X_2 - \sum X_2^2 * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}$$

$C =$ -0.800000

$B =$ 0.1302364

$A =$ 2.77339870

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A =$ 593.469911

$a = B =$ 0.1302364

$b = -C =$ 0.800000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

$\lambda =$ 593.5

$\psi =$ 0.1302364

$\eta =$ 0.80

$\theta =$ 3.0

APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

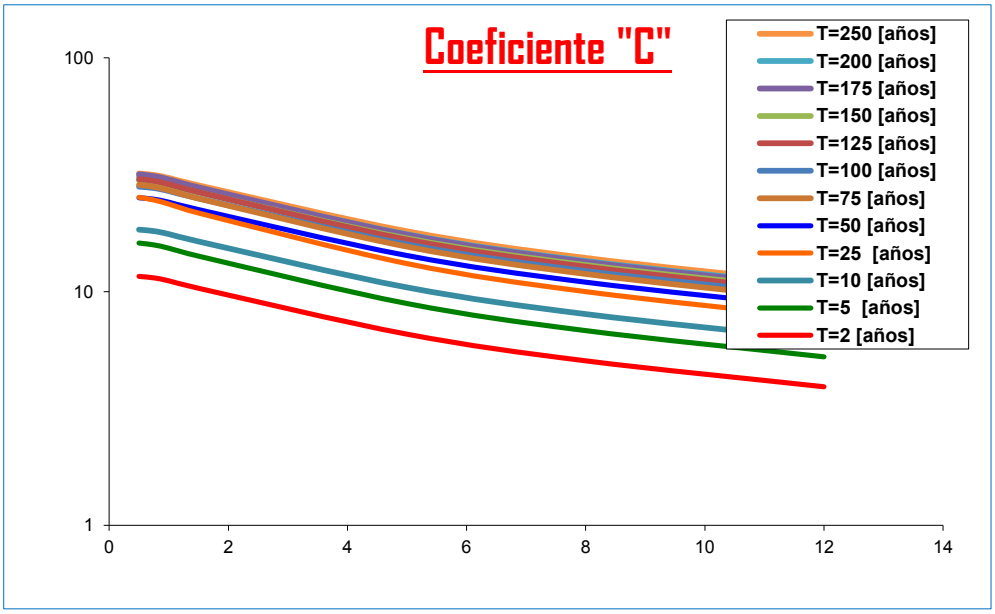
$$i = \frac{K * T_{\text{Re torno}}^{\ a}}{(D_{Duracion} + C)^b} \Leftrightarrow i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	11.61	11.45	11.12	10.33	6.57	5.06	3.92
5	16.13	15.84	15.33	14.18	8.89	6.81	5.26
10	18.41	18.15	17.62	16.38	10.42	8.01	6.21
25	25.32	24.65	23.70	21.68	13.17	10.00	7.68
50	25.20	24.85	24.13	22.43	14.27	10.97	8.50
75	28.63	28.07	27.12	25.02	15.57	11.89	9.17
100	28.13	27.73	26.93	25.03	15.92	12.24	9.49
125	30.28	29.74	28.79	26.63	16.70	12.78	9.87
150	29.84	29.42	28.57	26.55	16.89	12.99	10.06
175	31.76	31.20	30.20	27.93	17.51	13.41	10.36
200	31.06	30.62	29.73	27.64	17.58	13.52	10.47
250	32.00	31.55	30.63	28.47	18.11	13.93	10.79

Periodo (T)	C (Adoptado)
2	2
5	1.9
10	2
25	1.7
50	2
75	1.85
100	2
125	1.9
150	2
175	1.9
200	2
250	2



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} = 1.9375 \qquad \theta = \frac{\sum \theta_i}{K} = 2.0$$

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X1 = Log T	X2 = Log D
1	2	58.07	30	1.7639	0.3010	1.4771
2	5	77.41	30	1.8888	0.6990	1.4771
3	10	92.05	30	1.9640	1.0000	1.4771
4	25	111.39	30	2.0468	1.3979	1.4771
5	50	126.02	30	2.1005	1.6990	1.4771
6	75	134.58	30	2.1290	1.8751	1.4771
7	100	140.66	30	2.1482	2.0000	1.4771
8	125	145.37	30	2.1625	2.0969	1.4771
9	150	149.22	30	2.1738	2.1761	1.4771
10	175	152.47	30	2.1832	2.2430	1.4771
11	200	155.29	30	2.1911	2.3010	1.4771
12	250	160.00	30	2.2041	2.3979	1.4771
13	2	41.98	45	1.6231	0.3010	1.6532
14	5	55.97	45	1.7479	0.6990	1.6532
15	10	66.55	45	1.8231	1.0000	1.6532
16	25	80.53	45	1.9060	1.3979	1.6532
17	50	91.11	45	1.9596	1.6990	1.6532
18	75	97.30	45	1.9881	1.8751	1.6532
19	100	101.69	45	2.0073	2.0000	1.6532
20	125	105.10	45	2.0216	2.0969	1.6532
21	150	107.88	45	2.0329	2.1761	1.6532
22	175	110.23	45	2.0423	2.2430	1.6532
23	200	112.27	45	2.0503	2.3010	1.6532
24	250	115.68	45	2.0632	2.3979	1.6532
25	2	33.35	60	1.5231	0.3010	1.7782
26	5	44.46	60	1.6480	0.6990	1.7782
27	10	52.87	60	1.7232	1.0000	1.7782
28	25	63.98	60	1.8060	1.3979	1.7782
29	50	72.38	60	1.8596	1.6990	1.7782
30	75	77.30	60	1.8882	1.8751	1.7782
31	100	80.79	60	1.9073	2.0000	1.7782
32	125	83.49	60	1.9216	2.0969	1.7782
33	150	85.70	60	1.9330	2.1761	1.7782
34	175	87.57	60	1.9424	2.2430	1.7782

35	200	89.19	60	1.9503	2.3010	1.7782
36	250	91.90	60	1.9633	2.3979	1.7782
37	2	24.11	90	1.3822	0.3010	1.9542
38	5	32.14	90	1.5071	0.6990	1.9542
39	10	38.22	90	1.5823	1.0000	1.9542
40	25	46.25	90	1.6651	1.3979	1.9542
41	50	52.33	90	1.7188	1.6990	1.9542
42	75	55.88	90	1.7473	1.8751	1.9542
43	100	58.41	90	1.7665	2.0000	1.9542
44	125	60.36	90	1.7808	2.0969	1.9542
45	150	61.96	90	1.7921	2.1761	1.9542
46	175	63.31	90	1.8015	2.2430	1.9542
47	200	64.48	90	1.8094	2.3010	1.9542
48	250	66.44	90	1.8224	2.3979	1.9542
49	2	9.20	300	0.9639	0.3010	2.4771
50	5	12.27	300	1.0888	0.6990	2.4771
51	10	14.59	300	1.1640	1.0000	2.4771
52	25	17.65	300	1.2468	1.3979	2.4771
53	50	19.97	300	1.3005	1.6990	2.4771
54	75	21.33	300	1.3290	1.8751	2.4771
55	100	22.29	300	1.3482	2.0000	2.4771
56	125	23.04	300	1.3625	2.0969	2.4771
57	150	23.65	300	1.3738	2.1761	2.4771
58	175	24.17	300	1.3832	2.2430	2.4771
59	200	24.61	300	1.3911	2.3010	2.4771
60	250	25.36	300	1.4041	2.3979	2.4771
61	2	6.32	480	0.8006	0.3010	2.6812
62	5	8.42	480	0.9255	0.6990	2.6812
63	10	10.02	480	1.0007	1.0000	2.6812
64	25	12.12	480	1.0835	1.3979	2.6812
65	50	13.71	480	1.1372	1.6990	2.6812
66	75	14.65	480	1.1657	1.8751	2.6812
67	100	15.31	480	1.1849	2.0000	2.6812
68	125	15.82	480	1.1992	2.0969	2.6812
69	150	16.24	480	1.2105	2.1761	2.6812
70	175	16.59	480	1.2199	2.2430	2.6812
71	200	16.90	480	1.2278	2.3010	2.6812
72	250	17.41	480	1.2408	2.3979	2.6812
73	2	4.57	720	0.6598	0.3010	2.8573
74	5	6.09	720	0.7846	0.6990	2.8573
75	10	7.24	720	0.8598	1.0000	2.8573
76	25	8.76	720	0.9427	1.3979	2.8573
77	50	9.91	720	0.9963	1.6990	2.8573
78	75	10.59	720	1.0248	1.8751	2.8573
79	100	11.07	720	1.0440	2.0000	2.8573
80	125	11.44	720	1.0583	2.0969	2.8573
81	150	11.74	720	1.0696	2.1761	2.8573

82	175	12.00	720	1.0790	2.2430	2.8573
83	200	12.22	720	1.0870	2.3010	2.8573
84	250	12.59	720	1.1000	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	$Y*X_1$	$Y*X_2$	X_1*X_2	X_1^2	X_2^2
1	2	0.5310	2.6055	0.4447	0.0906	2.1819
2	5	1.3202	2.7900	1.0325	0.4886	2.1819
3	10	1.9640	2.9011	1.4771	1.0000	2.1819
4	25	2.8614	3.0234	2.0649	1.9542	2.1819
5	50	3.5686	3.1026	2.5096	2.8865	2.1819
6	75	3.9920	3.1448	2.7697	3.5159	2.1819
7	100	4.2963	3.1731	2.9542	4.0000	2.1819
8	125	4.5345	3.1942	3.0974	4.3970	2.1819
9	150	4.7304	3.2110	3.2144	4.7354	2.1819
10	175	4.8970	3.2248	3.3132	5.0312	2.1819
11	200	5.0419	3.2366	3.3989	5.2947	2.1819
12	250	5.2854	3.2558	3.5420	5.7501	2.1819
13	2	0.4886	2.6833	0.4977	0.0906	2.7331
14	5	1.2218	2.8897	1.1555	0.4886	2.7331
15	10	1.8231	3.0140	1.6532	1.0000	2.7331
16	25	2.6644	3.1510	2.3111	1.9542	2.7331
17	50	3.3293	3.2396	2.8088	2.8865	2.7331
18	75	3.7278	3.2868	3.0999	3.5159	2.7331
19	100	4.0146	3.3185	3.3064	4.0000	2.7331
20	125	4.2391	3.3421	3.4666	4.3970	2.7331
21	150	4.4239	3.3609	3.5975	4.7354	2.7331
22	175	4.5810	3.3764	3.7082	5.0312	2.7331
23	200	4.7177	3.3895	3.8041	5.2947	2.7331
24	250	4.9475	3.4110	3.9643	5.7501	2.7331
25	2	0.4585	2.7083	0.5353	0.0906	3.1618
26	5	1.1519	2.9304	1.2429	0.4886	3.1618
27	10	1.7232	3.0641	1.7782	1.0000	3.1618
28	25	2.5247	3.2114	2.4857	1.9542	3.1618
29	50	3.1595	3.3067	3.0210	2.8865	3.1618
30	75	3.5404	3.3574	3.3341	3.5159	3.1618
31	100	3.8147	3.3915	3.5563	4.0000	3.1618
32	125	4.0295	3.4170	3.7286	4.3970	3.1618
33	150	4.2064	3.4372	3.8694	4.7354	3.1618
34	175	4.3568	3.4538	3.9885	5.0312	3.1618
35	200	4.4877	3.4680	4.0916	5.2947	3.1618
36	250	4.7079	3.4910	4.2639	5.7501	3.1618
37	2	0.4161	2.7012	0.5883	0.0906	3.8191
38	5	1.0534	2.9453	1.3660	0.4886	3.8191
39	10	1.5823	3.0922	1.9542	1.0000	3.8191

40	25	2.3278	3.2541	2.7319	1.9542	3.8191
41	50	2.9201	3.3589	3.3202	2.8865	3.8191
42	75	3.2763	3.4146	3.6643	3.5159	3.8191
43	100	3.5329	3.4521	3.9085	4.0000	3.8191
44	125	3.7341	3.4801	4.0979	4.3970	3.8191
45	150	3.8998	3.5022	4.2526	4.7354	3.8191
46	175	4.0408	3.5205	4.3834	5.0312	3.8191
47	200	4.1636	3.5361	4.4968	5.2947	3.8191
48	250	4.3701	3.5615	4.6862	5.7501	3.8191
49	2	0.2902	2.3878	0.7457	0.0906	6.1361
50	5	0.7610	2.6971	1.7314	0.4886	6.1361
51	10	1.1640	2.8834	2.4771	1.0000	6.1361
52	25	1.7430	3.0886	3.4629	1.9542	6.1361
53	50	2.2094	3.2214	4.2086	2.8865	6.1361
54	75	2.4919	3.2921	4.6448	3.5159	6.1361
55	100	2.6963	3.3396	4.9542	4.0000	6.1361
56	125	2.8570	3.3750	5.1943	4.3970	6.1361
57	150	2.9896	3.4031	5.3904	4.7354	6.1361
58	175	3.1025	3.4263	5.5563	5.0312	6.1361
59	200	3.2011	3.4460	5.6999	5.2947	6.1361
60	250	3.3670	3.4782	5.9400	5.7501	6.1361
61	2	0.2410	2.1467	0.8071	0.0906	7.1891
62	5	0.6469	2.4815	1.8741	0.4886	7.1891
63	10	1.0007	2.6831	2.6812	1.0000	7.1891
64	25	1.5147	2.9053	3.7482	1.9542	7.1891
65	50	1.9320	3.0490	4.5553	2.8865	7.1891
66	75	2.1857	3.1255	5.0275	3.5159	7.1891
67	100	2.3697	3.1769	5.3625	4.0000	7.1891
68	125	2.5146	3.2153	5.6223	4.3970	7.1891
69	150	2.6342	3.2457	5.8346	4.7354	7.1891
70	175	2.7363	3.2708	6.0141	5.0312	7.1891
71	200	2.8253	3.2922	6.1696	5.2947	7.1891
72	250	2.9754	3.3270	6.4295	5.7501	7.1891
73	2	0.1986	1.8852	0.8601	0.0906	8.1643
74	5	0.5484	2.2420	1.9972	0.4886	8.1643
75	10	0.8598	2.4568	2.8573	1.0000	8.1643
76	25	1.3178	2.6935	3.9944	1.9542	8.1643
77	50	1.6927	2.8467	4.8545	2.8865	8.1643
78	75	1.9216	2.9283	5.3577	3.5159	8.1643
79	100	2.0880	2.9830	5.7147	4.0000	8.1643
80	125	2.2192	3.0239	5.9916	4.3970	8.1643
81	150	2.3277	3.0563	6.2178	4.7354	8.1643
82	175	2.4203	3.0831	6.4091	5.0312	8.1643
83	200	2.5012	3.1058	6.5748	5.2947	8.1643
84	250	2.6376	3.1429	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 131.121 $\quad \sum X_1 =$ 141.309

$\sum X_2 =$ 178.541 $\quad \sum Y * X_1 =$ 227.862

$\sum Y * X_2 =$ 261.786 $\quad \sum X_1 * X_2 =$ 300.350

$\sum X_1^{\,2} =$ 274.010 $\quad \sum X_2^{\,2} =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{\left(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}{\left(\sum (X_1 X_2) * \sum X_2 - \sum X_2^2 * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}$$

$C =$ -0.800000

$B =$ 0.2006963

$A =$ 2.92373719

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A =$ 838.952145

$a = B =$ 0.2006963

$b = -C =$ 0.800000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

$\lambda =$ 839.0

$\psi =$ 0.2006963

$\eta =$ 0.80

$\theta =$ 2.0

RESULTADOS DE DIFERENTES MODELOS PROPUESTOS

Modelo de Bernard aplicado a las principales ciudades y poblaciones del Departamento:

Ciudad en Estudio	ψ	η	λ
Tarija	0.162751	0.80	896.1416
Yacuiba	0.173453	0.80	1713.1456
Bermejo	0.159804	0.80	1496.2761
Padcaya	0.200696	0.80	838.9521
Iscayachi	0.130236	0.80	593.4699
Villamontes	0.155675	0.80	1646.4446
Carapari	0.164920	0.80	1450.0212
Valle de la Concepcion	0.158729	0.80	732.4949
Entre Rios	0.150840	0.80	1242.9759
San Lorenzo	0.125369	0.80	782.8759
El Puente	0.170281	0.80	465.5254

Modelo de Sherman aplicado a las principales ciudades y poblaciones del Departamento:

Ciudad en Estudio	θ	ψ	η	λ
Tarija	3	0.162751	0.80	896.1416
Yacuiba	2	0.173453	0.80	1713.1456
Bermejo	2	0.159804	0.80	1496.2761
Padcaya	2	0.200696	0.80	838.9521
Iscayachi	3	0.130236	0.80	593.4699
Villamontes	2	0.155675	0.80	1646.4446
Carapari	2	0.164920	0.80	1450.0212
Valle de la Concepcion	3	0.158729	0.80	732.4949
Entre Rios	2	0.150840	0.80	1242.9759
San Lorenzo	3	0.125369	0.80	782.8759
El Puente	4	0.170281	0.80	465.5254

APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

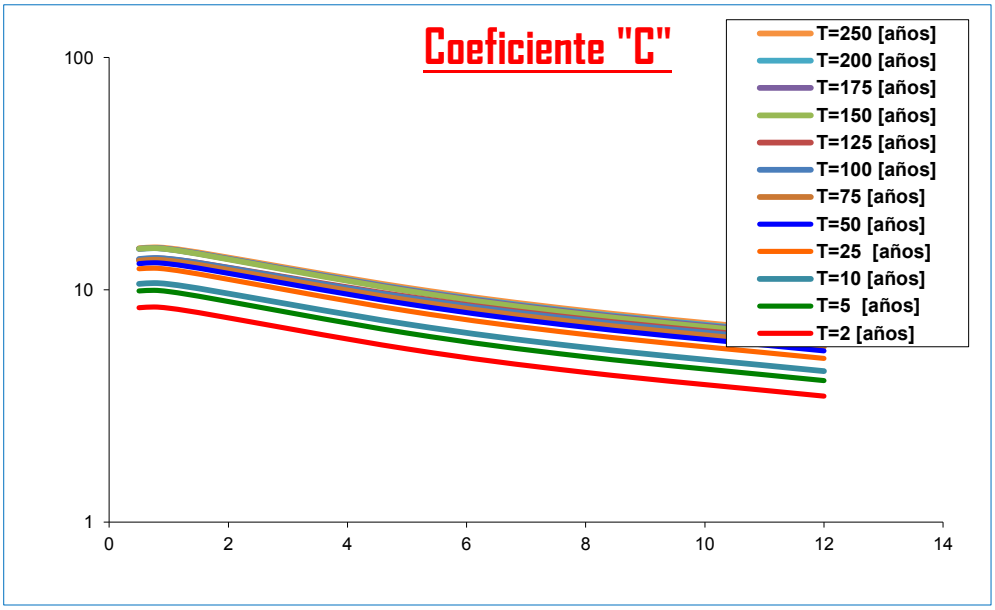
$$i = \frac{K * T_{\text{Re torno}}{}^{a}}{\left(D_{Duracion} + C\right)^{b}} \Leftrightarrow i = \frac{\lambda * T^{\psi}}{\left(d + \theta\right)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	8.37	8.43	8.33	7.97	5.56	4.41	3.48
5	9.89	9.94	9.82	9.38	6.51	5.15	4.06
10	10.60	10.69	10.58	10.14	7.11	5.64	4.46
25	12.32	12.39	12.24	11.69	8.11	6.41	5.06
50	12.96	13.06	12.93	12.39	8.69	6.89	5.46
75	13.35	13.47	13.34	12.81	9.03	7.18	5.69
100	13.56	13.70	13.58	13.06	9.25	7.37	5.84
125	13.48	13.65	13.55	13.07	9.35	7.47	5.94
150	15.02	15.11	14.93	14.26	9.90	7.82	6.18
175	15.02	15.13	14.96	14.31	9.98	7.91	6.25
200	14.99	15.11	14.95	14.33	10.05	7.97	6.31
250	15.09	15.23	15.08	14.48	10.21	8.11	6.43

Periodo (T)	C (Adoptado)
2	2.75
5	2.7
10	2.8
25	2.7
50	2.8
75	2.85
100	2.9
125	3
150	2.7
175	2.75
200	2.8
250	2.85



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} = 2.8000 \qquad \theta = \frac{\sum \theta_i}{K} = 3.0$$

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X1 = Log T	X2 = Log D
1	2	54.41	30	1.7357	0.3010	1.4771
2	5	63.27	30	1.8012	0.6990	1.4771
3	10	69.97	30	1.8449	1.0000	1.4771
4	25	78.83	30	1.8967	1.3979	1.4771
5	50	85.53	30	1.9321	1.6990	1.4771
6	75	89.45	30	1.9516	1.8751	1.4771
7	100	92.23	30	1.9649	2.0000	1.4771
8	125	94.39	30	1.9749	2.0969	1.4771
9	150	96.16	30	1.9830	2.1761	1.4771
10	175	97.65	30	1.9897	2.2430	1.4771
11	200	98.94	30	1.9954	2.3010	1.4771
12	250	101.09	30	2.0047	2.3979	1.4771
13	2	39.34	45	1.5948	0.3010	1.6532
14	5	45.74	45	1.6603	0.6990	1.6532
15	10	50.59	45	1.7041	1.0000	1.6532
16	25	56.99	45	1.7558	1.3979	1.6532
17	50	61.84	45	1.7913	1.6990	1.6532
18	75	64.67	45	1.8107	1.8751	1.6532
19	100	66.68	45	1.8240	2.0000	1.6532
20	125	68.24	45	1.8341	2.0969	1.6532
21	150	69.52	45	1.8421	2.1761	1.6532
22	175	70.60	45	1.8488	2.2430	1.6532
23	200	71.53	45	1.8545	2.3010	1.6532
24	250	73.09	45	1.8639	2.3979	1.6532
25	2	31.25	60	1.4949	0.3010	1.7782
26	5	36.34	60	1.5604	0.6990	1.7782
27	10	40.19	60	1.6041	1.0000	1.7782
28	25	45.28	60	1.6559	1.3979	1.7782
29	50	49.13	60	1.6913	1.6990	1.7782
30	75	51.38	60	1.7108	1.8751	1.7782
31	100	52.97	60	1.7241	2.0000	1.7782
32	125	54.21	60	1.7341	2.0969	1.7782
33	150	55.23	60	1.7421	2.1761	1.7782
34	175	56.08	60	1.7488	2.2430	1.7782

35	200	56.82	60	1.7545	2.3010	1.7782
36	250	58.06	60	1.7639	2.3979	1.7782
37	2	22.59	90	1.3540	0.3010	1.9542
38	5	26.27	90	1.4195	0.6990	1.9542
39	10	29.06	90	1.4632	1.0000	1.9542
40	25	32.73	90	1.5150	1.3979	1.9542
41	50	35.52	90	1.5504	1.6990	1.9542
42	75	37.14	90	1.5699	1.8751	1.9542
43	100	38.30	90	1.5832	2.0000	1.9542
44	125	39.20	90	1.5932	2.0969	1.9542
45	150	39.93	90	1.6013	2.1761	1.9542
46	175	40.55	90	1.6080	2.2430	1.9542
47	200	41.08	90	1.6137	2.3010	1.9542
48	250	41.98	90	1.6230	2.3979	1.9542
49	2	8.62	300	0.9357	0.3010	2.4771
50	5	10.03	300	1.0012	0.6990	2.4771
51	10	11.09	300	1.0449	1.0000	2.4771
52	25	12.49	300	1.0967	1.3979	2.4771
53	50	13.56	300	1.1321	1.6990	2.4771
54	75	14.18	300	1.1516	1.8751	2.4771
55	100	14.62	300	1.1649	2.0000	2.4771
56	125	14.96	300	1.1749	2.0969	2.4771
57	150	15.24	300	1.1830	2.1761	2.4771
58	175	15.48	300	1.1897	2.2430	2.4771
59	200	15.68	300	1.1954	2.3010	2.4771
60	250	16.02	300	1.2047	2.3979	2.4771
61	2	5.92	480	0.7724	0.3010	2.6812
62	5	6.88	480	0.8379	0.6990	2.6812
63	10	7.61	480	0.8816	1.0000	2.6812
64	25	8.58	480	0.9334	1.3979	2.6812
65	50	9.31	480	0.9688	1.6990	2.6812
66	75	9.73	480	0.9883	1.8751	2.6812
67	100	10.04	480	1.0016	2.0000	2.6812
68	125	10.27	480	1.0116	2.0969	2.6812
69	150	10.46	480	1.0197	2.1761	2.6812
70	175	10.63	480	1.0264	2.2430	2.6812
71	200	10.77	480	1.0321	2.3010	2.6812
72	250	11.00	480	1.0414	2.3979	2.6812
73	2	4.28	720	0.6315	0.3010	2.8573
74	5	4.98	720	0.6970	0.6990	2.8573
75	10	5.50	720	0.7408	1.0000	2.8573
76	25	6.20	720	0.7925	1.3979	2.8573
77	50	6.73	720	0.8280	1.6990	2.8573
78	75	7.04	720	0.8474	1.8751	2.8573
79	100	7.26	720	0.8607	2.0000	2.8573
80	125	7.43	720	0.8708	2.0969	2.8573
81	150	7.56	720	0.8788	2.1761	2.8573

82	175	7.68	720	0.8855	2.2430	2.8573
83	200	7.78	720	0.8912	2.3010	2.8573
84	250	7.95	720	0.9006	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	$Y*X_1$	$Y*X_2$	X_1*X_2	X_1^2	X_2^2
1	2	0.5225	2.5638	0.4447	0.0906	2.1819
2	5	1.2590	2.6606	1.0325	0.4886	2.1819
3	10	1.8449	2.7252	1.4771	1.0000	2.1819
4	25	2.6515	2.8017	2.0649	1.9542	2.1819
5	50	3.2826	2.8540	2.5096	2.8865	2.1819
6	75	3.6594	2.8827	2.7697	3.5159	2.1819
7	100	3.9298	2.9024	2.9542	4.0000	2.1819
8	125	4.1413	2.9172	3.0974	4.3970	2.1819
9	150	4.3151	2.9291	3.2144	4.7354	2.1819
10	175	4.4629	2.9390	3.3132	5.0312	2.1819
11	200	4.5914	2.9474	3.3989	5.2947	2.1819
12	250	4.8072	2.9612	3.5420	5.7501	2.1819
13	2	0.4801	2.6366	0.4977	0.0906	2.7331
14	5	1.1605	2.7449	1.1555	0.4886	2.7331
15	10	1.7041	2.8172	1.6532	1.0000	2.7331
16	25	2.4545	2.9028	2.3111	1.9542	2.7331
17	50	3.0433	2.9613	2.8088	2.8865	2.7331
18	75	3.3952	2.9935	3.0999	3.5159	2.7331
19	100	3.6480	3.0155	3.3064	4.0000	2.7331
20	125	3.8459	3.0321	3.4666	4.3970	2.7331
21	150	4.0086	3.0454	3.5975	4.7354	2.7331
22	175	4.1469	3.0564	3.7082	5.0312	2.7331
23	200	4.2672	3.0659	3.8041	5.2947	2.7331
24	250	4.4694	3.0813	3.9643	5.7501	2.7331
25	2	0.4500	2.6581	0.5353	0.0906	3.1618
26	5	1.0907	2.7746	1.2429	0.4886	3.1618
27	10	1.6041	2.8523	1.7782	1.0000	3.1618
28	25	2.3148	2.9444	2.4857	1.9542	3.1618
29	50	2.8735	3.0074	3.0210	2.8865	3.1618
30	75	3.2078	3.0420	3.3341	3.5159	3.1618
31	100	3.4481	3.0657	3.5563	4.0000	3.1618
32	125	3.6363	3.0835	3.7286	4.3970	3.1618
33	150	3.7911	3.0978	3.8694	4.7354	3.1618
34	175	3.9227	3.1097	3.9885	5.0312	3.1618
35	200	4.0372	3.1198	4.0916	5.2947	3.1618
36	250	4.2297	3.1365	4.2639	5.7501	3.1618
37	2	0.4076	2.6460	0.5883	0.0906	3.8191
38	5	0.9922	2.7741	1.3660	0.4886	3.8191
39	10	1.4632	2.8595	1.9542	1.0000	3.8191

40	25	2.1179	2.9607	2.7319	1.9542	3.8191
41	50	2.6341	3.0299	3.3202	2.8865	3.8191
42	75	2.9437	3.0680	3.6643	3.5159	3.8191
43	100	3.1664	3.0940	3.9085	4.0000	3.8191
44	125	3.3409	3.1136	4.0979	4.3970	3.8191
45	150	3.4845	3.1293	4.2526	4.7354	3.8191
46	175	3.6067	3.1423	4.3834	5.0312	3.8191
47	200	3.7131	3.1535	4.4968	5.2947	3.8191
48	250	3.8919	3.1718	4.6862	5.7501	3.8191
49	2	0.2817	2.3178	0.7457	0.0906	6.1361
50	5	0.6998	2.4801	1.7314	0.4886	6.1361
51	10	1.0449	2.5884	2.4771	1.0000	6.1361
52	25	1.5331	2.7167	3.4629	1.9542	6.1361
53	50	1.9235	2.8044	4.2086	2.8865	6.1361
54	75	2.1593	2.8526	4.6448	3.5159	6.1361
55	100	2.3298	2.8856	4.9542	4.0000	6.1361
56	125	2.4637	2.9105	5.1943	4.3970	6.1361
57	150	2.5743	2.9304	5.3904	4.7354	6.1361
58	175	2.6684	2.9469	5.5563	5.0312	6.1361
59	200	2.7506	2.9610	5.6999	5.2947	6.1361
60	250	2.8889	2.9843	5.9400	5.7501	6.1361
61	2	0.2325	2.0710	0.8071	0.0906	7.1891
62	5	0.5857	2.2466	1.8741	0.4886	7.1891
63	10	0.8816	2.3639	2.6812	1.0000	7.1891
64	25	1.3048	2.5027	3.7482	1.9542	7.1891
65	50	1.6460	2.5977	4.5553	2.8865	7.1891
66	75	1.8531	2.6499	5.0275	3.5159	7.1891
67	100	2.0032	2.6855	5.3625	4.0000	7.1891
68	125	2.1213	2.7125	5.6223	4.3970	7.1891
69	150	2.2189	2.7340	5.8346	4.7354	7.1891
70	175	2.3022	2.7519	6.0141	5.0312	7.1891
71	200	2.3748	2.7672	6.1696	5.2947	7.1891
72	250	2.4973	2.7923	6.4295	5.7501	7.1891
73	2	0.1901	1.8045	0.8601	0.0906	8.1643
74	5	0.4872	1.9916	1.9972	0.4886	8.1643
75	10	0.7408	2.1166	2.8573	1.0000	8.1643
76	25	1.1079	2.2645	3.9944	1.9542	8.1643
77	50	1.4067	2.3658	4.8545	2.8865	8.1643
78	75	1.5890	2.4214	5.3577	3.5159	8.1643
79	100	1.7215	2.4594	5.7147	4.0000	8.1643
80	125	1.8259	2.4881	5.9916	4.3970	8.1643
81	150	1.9124	2.5110	6.2178	4.7354	8.1643
82	175	1.9862	2.5301	6.4091	5.0312	8.1643
83	200	2.0506	2.5464	6.5748	5.2947	8.1643
84	250	2.1595	2.5732	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 117.953 $\quad \sum X_1 =$ 141.309

$\sum X_2 =$ 178.541 $\quad \sum Y * X_1 =$ 202.976

$\sum Y * X_2 =$ 233.798 $\quad \sum X_1 * X_2 =$ 300.350

$\sum X_1^{\,2} =$ 274.010 $\quad \sum X_2^{\,2} =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1) * ((\sum X_1)^2 - \sum X_1^2 * n) - (\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2) * (\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1)}{((\sum (X_1 X_2) * \sum X_2 - \sum X_2^2 * \sum X_1) * ((\sum X_1)^2 - \sum X_1^2 * n) - (\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n) * (\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1)}$$

$C =$ -0.800000

$B =$ 0.1253690

$A =$ 2.89369293

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A =$ 782.875915

$a = B =$ 0.1253690

$b = -C =$ 0.800000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

$\lambda =$ 782.9

$\psi =$ 0.1253690

$\eta =$ 0.80

$\theta =$ 3.0

APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

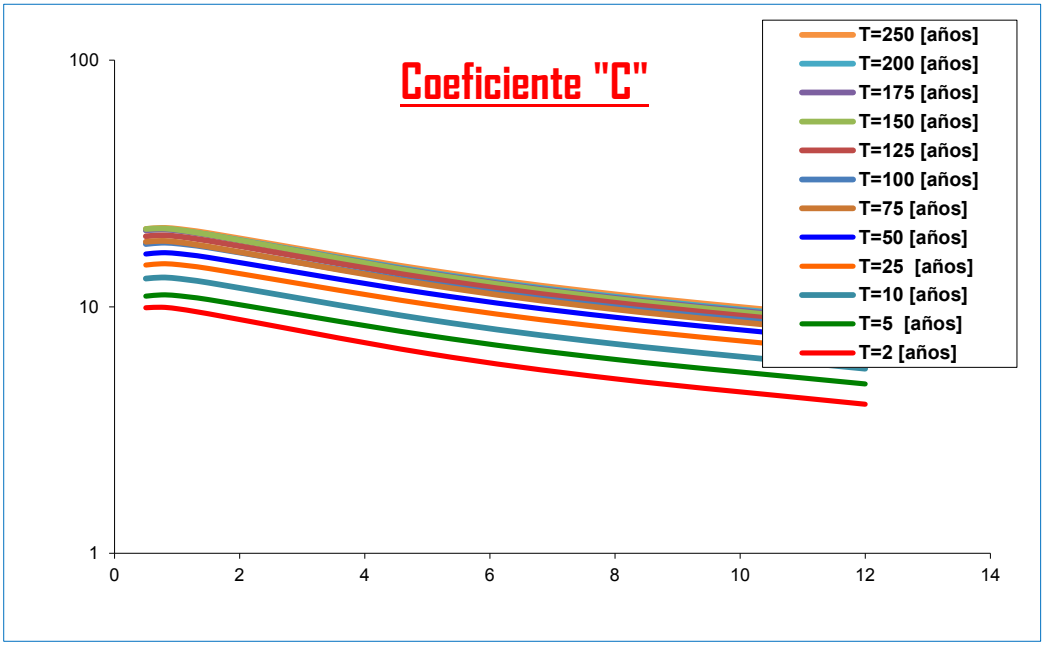
$$i = \frac{K * T_{\text{Re torno}}{}^{a}}{(D_{Duracion} + C)^{b}} \quad \Leftrightarrow \quad i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad.

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	9.91	9.95	9.82	9.37	6.46	5.10	4.02
5	11.03	11.17	11.09	10.69	7.65	6.11	4.86
10	13.01	13.14	13.03	12.52	8.87	7.07	5.61
25	14.76	14.94	14.83	14.30	10.23	8.18	6.50
50	16.36	16.56	16.45	15.85	11.35	9.06	7.21
75	18.35	18.50	18.30	17.54	12.30	9.76	7.73
100	17.97	18.18	18.06	17.41	12.46	9.95	7.92
125	19.31	19.49	19.30	18.53	13.06	10.38	8.23
150	20.68	20.80	20.54	19.62	13.62	10.77	8.50
175	20.43	20.59	20.38	19.53	13.70	10.87	8.60
200	20.45	20.63	20.44	19.62	13.83	10.99	8.71
250	20.68	20.89	20.71	19.90	14.10	11.23	8.91

Periodo (T)	C (Adoptado)
2	2.65
5	3
10	2.9
25	3
50	3
75	2.8
100	3
125	2.85
150	2.7
175	2.8
200	2.85
250	2.9



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} =$$ 2.8708 $$\theta = \frac{\sum \theta_i}{K} =$$ 3.0

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X1 = Log T	X2 = Log D
1	2	62.40	30	1.7952	0.3010	1.4771
2	5	77.24	30	1.8879	0.6990	1.4771
3	10	88.47	30	1.9468	1.0000	1.4771
4	25	103.31	30	2.0141	1.3979	1.4771
5	50	114.54	30	2.0589	1.6990	1.4771
6	75	121.10	30	2.0832	1.8751	1.4771
7	100	125.76	30	2.0996	2.0000	1.4771
8	125	129.38	30	2.1119	2.0969	1.4771
9	150	132.33	30	2.1217	2.1761	1.4771
10	175	134.83	30	2.1298	2.2430	1.4771
11	200	136.99	30	2.1367	2.3010	1.4771
12	250	140.60	30	2.1480	2.3979	1.4771
13	2	45.12	45	1.6543	0.3010	1.6532
14	5	55.84	45	1.7470	0.6990	1.6532
15	10	63.96	45	1.8059	1.0000	1.6532
16	25	74.69	45	1.8733	1.3979	1.6532
17	50	82.81	45	1.9181	1.6990	1.6532
18	75	87.56	45	1.9423	1.8751	1.6532
19	100	90.92	45	1.9587	2.0000	1.6532
20	125	93.54	45	1.9710	2.0969	1.6532
21	150	95.67	45	1.9808	2.1761	1.6532
22	175	97.48	45	1.9889	2.2430	1.6532
23	200	99.04	45	1.9958	2.3010	1.6532
24	250	101.65	45	2.0071	2.3979	1.6532
25	2	35.84	60	1.5544	0.3010	1.7782
26	5	44.36	60	1.6470	0.6990	1.7782
27	10	50.81	60	1.7060	1.0000	1.7782
28	25	59.34	60	1.7733	1.3979	1.7782
29	50	65.78	60	1.8181	1.6990	1.7782
30	75	69.56	60	1.8423	1.8751	1.7782
31	100	72.23	60	1.8587	2.0000	1.7782
32	125	74.31	60	1.8710	2.0969	1.7782
33	150	76.00	60	1.8808	2.1761	1.7782
34	175	77.44	60	1.8890	2.2430	1.7782
35	200	78.68	60	1.8959	2.3010	1.7782

36	250	80.76	60	1.9072	2.3979	1.7782
37	2	25.91	90	1.4135	0.3010	1.9542
38	5	32.07	90	1.5062	0.6990	1.9542
39	10	36.74	90	1.5651	1.0000	1.9542
40	25	42.90	90	1.6324	1.3979	1.9542
41	50	47.56	90	1.6772	1.6990	1.9542
42	75	50.29	90	1.7015	1.8751	1.9542
43	100	52.22	90	1.7179	2.0000	1.9542
44	125	53.72	90	1.7302	2.0969	1.9542
45	150	54.95	90	1.7400	2.1761	1.9542
46	175	55.99	90	1.7481	2.2430	1.9542
47	200	56.88	90	1.7550	2.3010	1.9542
48	250	58.38	90	1.7663	2.3979	1.9542
49	2	9.89	300	0.9952	0.3010	2.4771
50	5	12.24	300	1.0879	0.6990	2.4771
51	10	14.02	300	1.1468	1.0000	2.4771
52	25	16.37	300	1.2141	1.3979	2.4771
53	50	18.15	300	1.2589	1.6990	2.4771
54	75	19.19	300	1.2832	1.8751	2.4771
55	100	19.93	300	1.2996	2.0000	2.4771
56	125	20.50	300	1.3119	2.0969	2.4771
57	150	20.97	300	1.3217	2.1761	2.4771
58	175	21.37	300	1.3298	2.2430	2.4771
59	200	21.71	300	1.3367	2.3010	2.4771
60	250	22.28	300	1.3480	2.3979	2.4771
61	2	6.79	480	0.8319	0.3010	2.6812
62	5	8.41	480	0.9246	0.6990	2.6812
63	10	9.63	480	0.9835	1.0000	2.6812
64	25	11.24	480	1.0508	1.3979	2.6812
65	50	12.46	480	1.0956	1.6990	2.6812
66	75	13.18	480	1.1199	1.8751	2.6812
67	100	13.69	480	1.1363	2.0000	2.6812
68	125	14.08	480	1.1486	2.0969	2.6812
69	150	14.40	480	1.1584	2.1761	2.6812
70	175	14.67	480	1.1665	2.2430	2.6812
71	200	14.91	480	1.1734	2.3010	2.6812
72	250	15.30	480	1.1847	2.3979	2.6812
73	2	4.91	720	0.6910	0.3010	2.8573
74	5	6.08	720	0.7837	0.6990	2.8573
75	10	6.96	720	0.8426	1.0000	2.8573
76	25	8.13	720	0.9100	1.3979	2.8573
77	50	9.01	720	0.9548	1.6990	2.8573
78	75	9.53	720	0.9790	1.8751	2.8573
79	100	9.89	720	0.9954	2.0000	2.8573
80	125	10.18	720	1.0077	2.0969	2.8573
81	150	10.41	720	1.0175	2.1761	2.8573
82	175	10.61	720	1.0256	2.2430	2.8573

83	200	10.78	720	1.0325	2.3010	2.8573
84	250	11.06	720	1.0438	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	$Y*X_1$	$Y*X_2$	X_1*X_2	X_1^2	X_2^2
1	2	0.5404	2.6517	0.4447	0.0906	2.1819
2	5	1.3196	2.7886	1.0325	0.4886	2.1819
3	10	1.9468	2.8756	1.4771	1.0000	2.1819
4	25	2.8156	2.9751	2.0649	1.9542	2.1819
5	50	3.4981	3.0413	2.5096	2.8865	2.1819
6	75	3.9060	3.0771	2.7697	3.5159	2.1819
7	100	4.1991	3.1013	2.9542	4.0000	2.1819
8	125	4.4284	3.1195	3.0974	4.3970	2.1819
9	150	4.6169	3.1339	3.2144	4.7354	2.1819
10	175	4.7772	3.1459	3.3132	5.0312	2.1819
11	200	4.9166	3.1561	3.3989	5.2947	2.1819
12	250	5.1508	3.1728	3.5420	5.7501	2.1819
13	2	0.4980	2.7349	0.4977	0.0906	2.7331
14	5	1.2211	2.8881	1.1555	0.4886	2.7331
15	10	1.8059	2.9856	1.6532	1.0000	2.7331
16	25	2.6187	3.0969	2.3111	1.9542	2.7331
17	50	3.2587	3.1710	2.8088	2.8865	2.7331
18	75	3.6419	3.2110	3.0999	3.5159	2.7331
19	100	3.9174	3.2381	3.3064	4.0000	2.7331
20	125	4.1330	3.2585	3.4666	4.3970	2.7331
21	150	4.3104	3.2747	3.5975	4.7354	2.7331
22	175	4.4612	3.2881	3.7082	5.0312	2.7331
23	200	4.5924	3.2995	3.8041	5.2947	2.7331
24	250	4.8130	3.3182	3.9643	5.7501	2.7331
25	2	0.4679	2.7639	0.5353	0.0906	3.1618
26	5	1.1512	2.9287	1.2429	0.4886	3.1618
27	10	1.7060	3.0335	1.7782	1.0000	3.1618
28	25	2.4790	3.1532	2.4857	1.9542	3.1618
29	50	3.0889	3.2329	3.0210	2.8865	3.1618
30	75	3.4545	3.2759	3.3341	3.5159	3.1618
31	100	3.7175	3.3051	3.5563	4.0000	3.1618
32	125	3.9234	3.3270	3.7286	4.3970	3.1618
33	150	4.0929	3.3444	3.8694	4.7354	3.1618
34	175	4.2370	3.3588	3.9885	5.0312	3.1618
35	200	4.3624	3.3711	4.0916	5.2947	3.1618
36	250	4.5733	3.3912	4.2639	5.7501	3.1618
37	2	0.4255	2.7623	0.5883	0.0906	3.8191
38	5	1.0528	2.9434	1.3660	0.4886	3.8191
39	10	1.5651	3.0586	1.9542	1.0000	3.8191
40	25	2.2821	3.1902	2.7319	1.9542	3.8191

41	50	2.8496	3.2777	3.3202	2.8865	3.8191
42	75	3.1903	3.3251	3.6643	3.5159	3.8191
43	100	3.4357	3.3571	3.9085	4.0000	3.8191
44	125	3.6280	3.3812	4.0979	4.3970	3.8191
45	150	3.7863	3.4003	4.2526	4.7354	3.8191
46	175	3.9210	3.4162	4.3834	5.0312	3.8191
47	200	4.0383	3.4297	4.4968	5.2947	3.8191
48	250	4.2355	3.4518	4.6862	5.7501	3.8191
49	2	0.2996	2.4652	0.7457	0.0906	6.1361
50	5	0.7604	2.6947	1.7314	0.4886	6.1361
51	10	1.1468	2.8407	2.4771	1.0000	6.1361
52	25	1.6973	3.0076	3.4629	1.9542	6.1361
53	50	2.1389	3.1186	4.2086	2.8865	6.1361
54	75	2.4060	3.1785	4.6448	3.5159	6.1361
55	100	2.5991	3.2191	4.9542	4.0000	6.1361
56	125	2.7508	3.2496	5.1943	4.3970	6.1361
57	150	2.8760	3.2739	5.3904	4.7354	6.1361
58	175	2.9827	3.2940	5.5563	5.0312	6.1361
59	200	3.0758	3.3111	5.6999	5.2947	6.1361
60	250	3.2324	3.3391	5.9400	5.7501	6.1361
61	2	0.2504	2.2305	0.8071	0.0906	7.1891
62	5	0.6462	2.4790	1.8741	0.4886	7.1891
63	10	0.9835	2.6370	2.6812	1.0000	7.1891
64	25	1.4690	2.8176	3.7482	1.9542	7.1891
65	50	1.8615	2.9377	4.5553	2.8865	7.1891
66	75	2.0998	3.0026	5.0275	3.5159	7.1891
67	100	2.2725	3.0466	5.3625	4.0000	7.1891
68	125	2.4084	3.0796	5.6223	4.3970	7.1891
69	150	2.5207	3.1058	5.8346	4.7354	7.1891
70	175	2.6165	3.1276	6.0141	5.0312	7.1891
71	200	2.7000	3.1461	6.1696	5.2947	7.1891
72	250	2.8408	3.1765	6.4295	5.7501	7.1891
73	2	0.2080	1.9745	0.8601	0.0906	8.1643
74	5	0.5478	2.2393	1.9972	0.4886	8.1643
75	10	0.8426	2.4076	2.8573	1.0000	8.1643
76	25	1.2721	2.6001	3.9944	1.9542	8.1643
77	50	1.6221	2.7281	4.8545	2.8865	8.1643
78	75	1.8357	2.7973	5.3577	3.5159	8.1643
79	100	1.9908	2.8441	5.7147	4.0000	8.1643
80	125	2.1130	2.8793	5.9916	4.3970	8.1643
81	150	2.2141	2.9073	6.2178	4.7354	8.1643
82	175	2.3005	2.9305	6.4091	5.0312	8.1643
83	200	2.3759	2.9502	6.5748	5.2947	8.1643
84	250	2.5030	2.9826	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 128.165 $\sum X_1 =$ 141.309

$\sum X_2 =$ 178.541 $\sum Y * X_1 =$ 221.512

$\sum Y * X_2 =$ 255.503 $\sum X_1 * X_2 =$ 300.350

$\sum X_1^{\,2} =$ 274.010 $\sum X_2^{\,2} =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{\left(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^{\,2} * n\right) - \left(\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2\right) * \left(\sum X_1^{\,2} * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}{\left(\sum (X_1 X_2) * \sum X_2 - \sum X_2^{\,2} * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^{\,2} * n\right) - \left(\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n\right) * \left(\sum X_1^{\,2} * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}$$

$C =$ -0.80000

$B =$ 0.1627506

$A =$ 2.952377

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A =$ 896.1416

$a = B =$ 0.1627506

$b = -C =$ 0.80000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

$\lambda =$ 896.142

$\psi =$ 0.1627506

$\eta =$ 0.80

$\theta =$ 3.0

APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

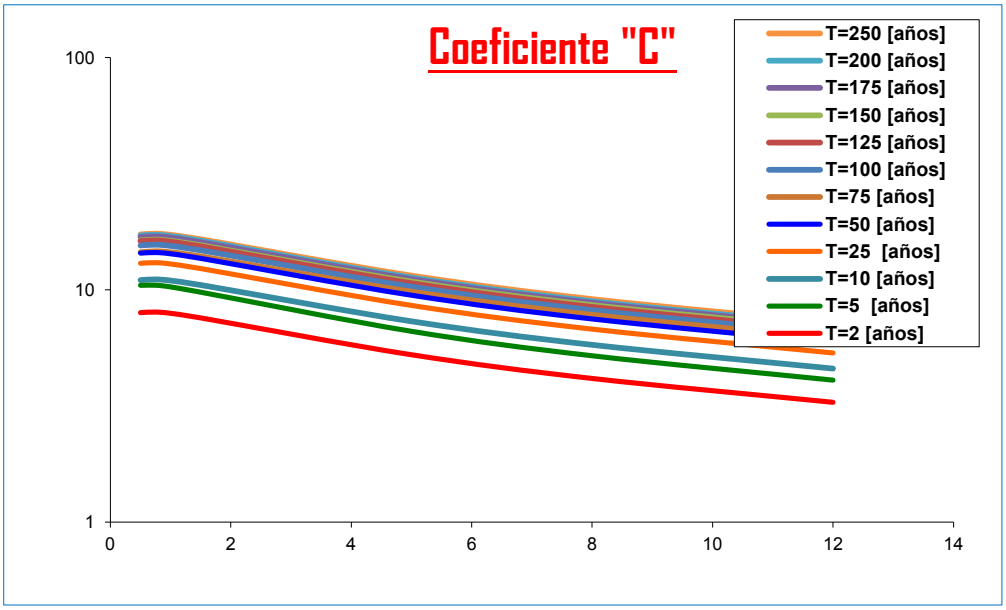
$$i = \frac{K * T_{Re\ torno}{}^{a}}{(D_{Duracion} + C)^{b}} \Leftrightarrow i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	7.97	8.02	7.92	7.57	5.25	4.15	3.28
5	10.45	10.46	10.29	9.76	6.62	5.20	4.08
10	11.00	11.08	10.96	10.48	7.31	5.79	4.58
25	13.00	13.08	12.92	12.34	8.56	6.77	5.34
50	14.38	14.47	14.29	13.65	9.47	7.49	5.91
75	14.51	14.64	14.50	13.92	9.81	7.80	6.18
100	15.52	15.63	15.45	14.78	10.31	8.17	6.46
125	16.21	16.30	16.10	15.38	10.67	8.44	6.66
150	16.31	16.43	16.24	15.54	10.84	8.59	6.79
175	16.88	16.98	16.77	16.02	11.12	8.79	6.94
200	17.14	17.24	17.03	16.27	11.29	8.93	7.05
250	17.32	17.44	17.24	16.50	11.51	9.12	7.20

Periodo (T)	C (Adoptado)
2	2.7
5	2.5
10	2.75
25	2.7
50	2.7
75	2.85
100	2.75
125	2.7
150	2.75
175	2.7
200	2.7
250	2.75



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} = 2.7125 \qquad \theta = \frac{\sum \theta_i}{K} = 3.0$$

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X1 = Log T	X2 = Log D
1	2	51.01	30	1.7077	0.3010	1.4771
2	5	62.69	30	1.7972	0.6990	1.4771
3	10	71.53	30	1.8545	1.0000	1.4771
4	25	83.21	30	1.9202	1.3979	1.4771
5	50	92.04	30	1.9640	1.6990	1.4771
6	75	97.21	30	1.9877	1.8751	1.4771
7	100	100.88	30	2.0038	2.0000	1.4771
8	125	103.72	30	2.0159	2.0969	1.4771
9	150	106.05	30	2.0255	2.1761	1.4771
10	175	108.01	30	2.0335	2.2430	1.4771
11	200	109.71	30	2.0403	2.3010	1.4771
12	250	112.56	30	2.0514	2.3979	1.4771
13	2	36.88	45	1.5668	0.3010	1.6532
14	5	45.33	45	1.6564	0.6990	1.6532
15	10	51.71	45	1.7136	1.0000	1.6532
16	25	60.16	45	1.7793	1.3979	1.6532
17	50	66.55	45	1.8231	1.6990	1.6532
18	75	70.28	45	1.8468	1.8751	1.6532
19	100	72.93	45	1.8629	2.0000	1.6532
20	125	74.99	45	1.8750	2.0969	1.6532
21	150	76.67	45	1.8846	2.1761	1.6532
22	175	78.09	45	1.8926	2.2430	1.6532
23	200	79.32	45	1.8994	2.3010	1.6532
24	250	81.38	45	1.9105	2.3979	1.6532
25	2	29.30	60	1.4669	0.3010	1.7782
26	5	36.01	60	1.5564	0.6990	1.7782
27	10	41.08	60	1.6137	1.0000	1.7782
28	25	47.79	60	1.6793	1.3979	1.7782
29	50	52.87	60	1.7232	1.6990	1.7782
30	75	55.83	60	1.7469	1.8751	1.7782
31	100	57.94	60	1.7630	2.0000	1.7782
32	125	59.57	60	1.7751	2.0969	1.7782
33	150	60.91	60	1.7847	2.1761	1.7782
34	175	62.04	60	1.7926	2.2430	1.7782

35	200	63.01	60	1.7994	2.3010	1.7782
36	250	64.65	60	1.8106	2.3979	1.7782
37	2	21.18	90	1.3260	0.3010	1.9542
38	5	26.03	90	1.4155	0.6990	1.9542
39	10	29.70	90	1.4728	1.0000	1.9542
40	25	34.55	90	1.5385	1.3979	1.9542
41	50	38.22	90	1.5823	1.6990	1.9542
42	75	40.37	90	1.6060	1.8751	1.9542
43	100	41.89	90	1.6221	2.0000	1.9542
44	125	43.07	90	1.6342	2.0969	1.9542
45	150	44.04	90	1.6438	2.1761	1.9542
46	175	44.85	90	1.6518	2.2430	1.9542
47	200	45.56	90	1.6586	2.3010	1.9542
48	250	46.74	90	1.6697	2.3979	1.9542
49	2	8.09	300	0.9077	0.3010	2.4771
50	5	9.94	300	0.9972	0.6990	2.4771
51	10	11.34	300	1.0545	1.0000	2.4771
52	25	13.19	300	1.1202	1.3979	2.4771
53	50	14.59	300	1.1640	1.6990	2.4771
54	75	15.41	300	1.1877	1.8751	2.4771
55	100	15.99	300	1.2038	2.0000	2.4771
56	125	16.44	300	1.2159	2.0969	2.4771
57	150	16.81	300	1.2255	2.1761	2.4771
58	175	17.12	300	1.2335	2.2430	2.4771
59	200	17.39	300	1.2403	2.3010	2.4771
60	250	17.84	300	1.2514	2.3979	2.4771
61	2	5.55	480	0.7444	0.3010	2.6812
62	5	6.82	480	0.8339	0.6990	2.6812
63	10	7.78	480	0.8912	1.0000	2.6812
64	25	9.05	480	0.9569	1.3979	2.6812
65	50	10.02	480	1.0007	1.6990	2.6812
66	75	10.58	480	1.0244	1.8751	2.6812
67	100	10.98	480	1.0405	2.0000	2.6812
68	125	11.29	480	1.0526	2.0969	2.6812
69	150	11.54	480	1.0622	2.1761	2.6812
70	175	11.75	480	1.0702	2.2430	2.6812
71	200	11.94	480	1.0770	2.3010	2.6812
72	250	12.25	480	1.0881	2.3979	2.6812
73	2	4.01	720	0.6035	0.3010	2.8573
74	5	4.93	720	0.6931	0.6990	2.8573
75	10	5.63	720	0.7503	1.0000	2.8573
76	25	6.55	720	0.8160	1.3979	2.8573
77	50	7.24	720	0.8598	1.6990	2.8573
78	75	7.65	720	0.8835	1.8751	2.8573
79	100	7.94	720	0.8996	2.0000	2.8573
80	125	8.16	720	0.9117	2.0969	2.8573
81	150	8.34	720	0.9213	2.1761	2.8573

82	175	8.50	720	0.9293	2.2430	2.8573
83	200	8.63	720	0.9361	2.3010	2.8573
84	250	8.86	720	0.9472	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	$Y*X_1$	$Y*X_2$	X_1*X_2	X_1^2	X_2^2
1	2	0.5141	2.5225	0.4447	0.0906	2.1819
2	5	1.2562	2.6547	1.0325	0.4886	2.1819
3	10	1.8545	2.7393	1.4771	1.0000	2.1819
4	25	2.6843	2.8363	2.0649	1.9542	2.1819
5	50	3.3368	2.9011	2.5096	2.8865	2.1819
6	75	3.7271	2.9361	2.7697	3.5159	2.1819
7	100	4.0076	2.9599	2.9542	4.0000	2.1819
8	125	4.2271	2.9777	3.0974	4.3970	2.1819
9	150	4.4077	2.9919	3.2144	4.7354	2.1819
10	175	4.5612	3.0037	3.3132	5.0312	2.1819
11	200	4.6947	3.0137	3.3989	5.2947	2.1819
12	250	4.9191	3.0301	3.5420	5.7501	2.1819
13	2	0.4717	2.5903	0.4977	0.0906	2.7331
14	5	1.1577	2.7383	1.1555	0.4886	2.7331
15	10	1.7136	2.8330	1.6532	1.0000	2.7331
16	25	2.4873	2.9416	2.3111	1.9542	2.7331
17	50	3.0974	3.0140	2.8088	2.8865	2.7331
18	75	3.4629	3.0532	3.0999	3.5159	2.7331
19	100	3.7259	3.0798	3.3064	4.0000	2.7331
20	125	3.9317	3.0998	3.4666	4.3970	2.7331
21	150	4.1011	3.1157	3.5975	4.7354	2.7331
22	175	4.2452	3.1289	3.7082	5.0312	2.7331
23	200	4.3705	3.1401	3.8041	5.2947	2.7331
24	250	4.5813	3.1585	3.9643	5.7501	2.7331
25	2	0.4416	2.6083	0.5353	0.0906	3.1618
26	5	1.0879	2.7675	1.2429	0.4886	3.1618
27	10	1.6137	2.8693	1.7782	1.0000	3.1618
28	25	2.3476	2.9861	2.4857	1.9542	3.1618
29	50	2.9276	3.0641	3.0210	2.8865	3.1618
30	75	3.2755	3.1062	3.3341	3.5159	3.1618
31	100	3.5259	3.1348	3.5563	4.0000	3.1618
32	125	3.7221	3.1563	3.7286	4.3970	3.1618
33	150	3.8836	3.1734	3.8694	4.7354	3.1618
34	175	4.0210	3.1876	3.9885	5.0312	3.1618
35	200	4.1406	3.1997	4.0916	5.2947	3.1618
36	250	4.3416	3.2194	4.2639	5.7501	3.1618
37	2	0.3992	2.5913	0.5883	0.0906	3.8191
38	5	0.9894	2.7663	1.3660	0.4886	3.8191
39	10	1.4728	2.8782	1.9542	1.0000	3.8191

40	25	2.1507	3.0065	2.7319	1.9542	3.8191
41	50	2.6883	3.0922	3.3202	2.8865	3.8191
42	75	3.0114	3.1386	3.6643	3.5159	3.8191
43	100	3.2442	3.1700	3.9085	4.0000	3.8191
44	125	3.4267	3.1936	4.0979	4.3970	3.8191
45	150	3.5771	3.2124	4.2526	4.7354	3.8191
46	175	3.7050	3.2280	4.3834	5.0312	3.8191
47	200	3.8164	3.2412	4.4968	5.2947	3.8191
48	250	4.0038	3.2630	4.6862	5.7501	3.8191
49	2	0.2732	2.2485	0.7457	0.0906	6.1361
50	5	0.6970	2.4702	1.7314	0.4886	6.1361
51	10	1.0545	2.6121	2.4771	1.0000	6.1361
52	25	1.5659	2.7748	3.4629	1.9542	6.1361
53	50	1.9776	2.8834	4.2086	2.8865	6.1361
54	75	2.2270	2.9421	4.6448	3.5159	6.1361
55	100	2.4076	2.9820	4.9542	4.0000	6.1361
56	125	2.5496	3.0119	5.1943	4.3970	6.1361
57	150	2.6668	3.0357	5.3904	4.7354	6.1361
58	175	2.7667	3.0555	5.5563	5.0312	6.1361
59	200	2.8539	3.0723	5.6999	5.2947	6.1361
60	250	3.0007	3.0998	5.9400	5.7501	6.1361
61	2	0.2241	1.9959	0.8071	0.0906	7.1891
62	5	0.5829	2.2360	1.8741	0.4886	7.1891
63	10	0.8912	2.3895	2.6812	1.0000	7.1891
64	25	1.3376	2.5656	3.7482	1.9542	7.1891
65	50	1.7002	2.6831	4.5553	2.8865	7.1891
66	75	1.9209	2.7467	5.0275	3.5159	7.1891
67	100	2.0810	2.7898	5.3625	4.0000	7.1891
68	125	2.2072	2.8222	5.6223	4.3970	7.1891
69	150	2.3114	2.8480	5.8346	4.7354	7.1891
70	175	2.4004	2.8694	6.0141	5.0312	7.1891
71	200	2.4781	2.8876	6.1696	5.2947	7.1891
72	250	2.6092	2.9174	6.4295	5.7501	7.1891
73	2	0.1817	1.7245	0.8601	0.0906	8.1643
74	5	0.4844	1.9803	1.9972	0.4886	8.1643
75	10	0.7503	2.1439	2.8573	1.0000	8.1643
76	25	1.1407	2.3316	3.9944	1.9542	8.1643
77	50	1.4608	2.4568	4.8545	2.8865	8.1643
78	75	1.6567	2.5246	5.3577	3.5159	8.1643
79	100	1.7993	2.5705	5.7147	4.0000	8.1643
80	125	1.9118	2.6050	5.9916	4.3970	8.1643
81	150	2.0049	2.6325	6.2178	4.7354	8.1643
82	175	2.0845	2.6553	6.4091	5.0312	8.1643
83	200	2.1540	2.6747	6.5748	5.2947	8.1643
84	250	2.2713	2.7065	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 120.241 $\quad \sum X_1 =$ 141.309

$\sum X_2 =$ 178.541 $\quad \sum Y * X_1 =$ 208.035

$\sum Y * X_2 =$ 238.660 $\quad \sum X_1 * X_2 =$ 300.350

$\sum X_1^{\,2} =$ 274.010 $\quad \sum X_2^{\,2} =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{\left(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^{\,2} * n\right) - \left(\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2\right) * \left(\sum X_1^{\,2} * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}{\left(\sum (X_1 X_2) * \sum X_2 - \sum X_2^{\,2} * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^{\,2} * n\right) - \left(\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n\right) * \left(\sum X_1^{\,2} * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}$$

$C =$ -0.800000

$B =$ 0.1587291

$A =$ 2.86480463

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A =$ 732.494947

$a = B =$ 0.1587291

$b = -C =$ 0.800000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

$\lambda =$ 732.5

$\psi =$ 0.1587291

$\eta =$ 0.80

$\theta =$ 3.0

APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

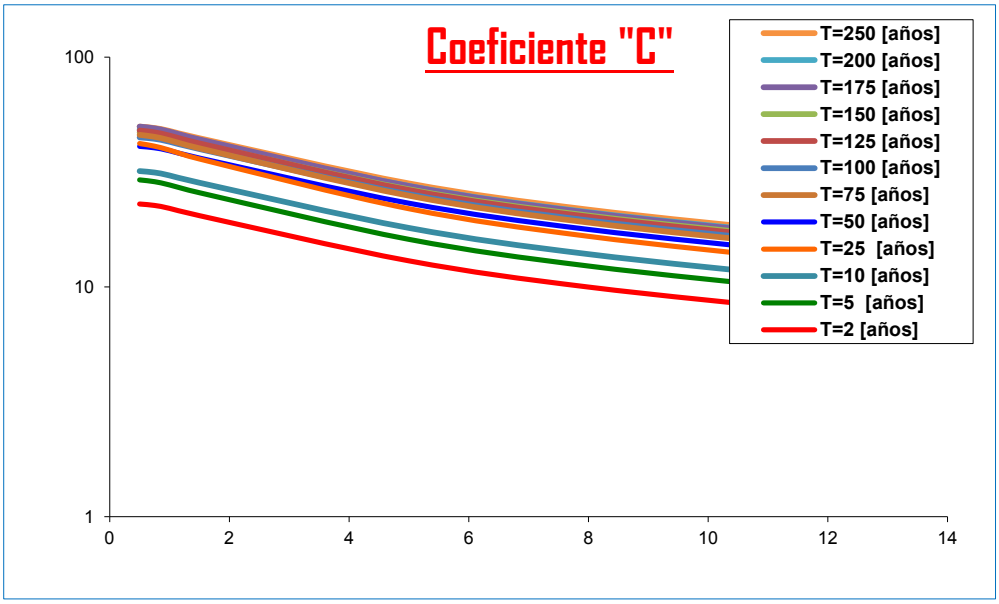
$$i = \frac{K * T_{\text{Re torno}}^{\ a}}{(D_{Duracion} + C)^b} \Leftrightarrow i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	22.93	22.61	21.95	20.41	12.98	9.98	7.73
5	29.20	28.68	27.76	25.68	16.10	12.33	9.52
10	31.89	31.44	30.53	28.38	18.05	13.88	10.75
25	42.03	40.93	39.34	36.00	21.88	16.60	12.75
50	40.85	40.27	39.10	36.35	23.12	17.78	13.77
75	45.86	44.95	43.43	40.07	24.93	19.05	14.69
100	44.71	44.07	42.79	39.78	25.30	19.46	15.07
125	47.86	47.01	45.50	42.09	26.38	20.20	15.60
150	46.96	46.30	44.95	41.79	26.58	20.44	15.83
175	49.81	48.92	47.35	43.80	27.46	21.03	16.24
200	48.56	47.88	46.49	43.21	27.49	21.14	16.37
250	49.80	49.10	47.68	44.32	28.19	21.68	16.79

Periodo (T)	C (Adoptado)
2	2
5	1.9
10	2
25	1.7
50	2
75	1.85
100	2
125	1.9
150	2
175	1.9
200	2
250	2



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} =$$ 1.9375 $$\theta = \frac{\sum \theta_i}{K} =$$ 2.0

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X1 = Log T	X2 = Log D
1	2	114.67	30	2.0595	0.3010	1.4771
2	5	140.17	30	2.1467	0.6990	1.4771
3	10	159.46	30	2.2026	1.0000	1.4771
4	25	184.95	30	2.2671	1.3979	1.4771
5	50	204.24	30	2.3101	1.6990	1.4771
6	75	215.52	30	2.3335	1.8751	1.4771
7	100	223.53	30	2.3493	2.0000	1.4771
8	125	229.74	30	2.3612	2.0969	1.4771
9	150	234.81	30	2.3707	2.1761	1.4771
10	175	239.10	30	2.3786	2.2430	1.4771
11	200	242.81	30	2.3853	2.3010	1.4771
12	250	249.02	30	2.3962	2.3979	1.4771
13	2	82.91	45	1.9186	0.3010	1.6532
14	5	101.34	45	2.0058	0.6990	1.6532
15	10	115.28	45	2.0618	1.0000	1.6532
16	25	133.72	45	2.1262	1.3979	1.6532
17	50	147.66	45	2.1693	1.6990	1.6532
18	75	155.82	45	2.1926	1.8751	1.6532
19	100	161.61	45	2.2085	2.0000	1.6532
20	125	166.10	45	2.2204	2.0969	1.6532
21	150	169.76	45	2.2298	2.1761	1.6532
22	175	172.86	45	2.2377	2.2430	1.6532
23	200	175.55	45	2.2444	2.3010	1.6532
24	250	180.04	45	2.2554	2.3979	1.6532
25	2	65.86	60	1.8186	0.3010	1.7782
26	5	80.51	60	1.9058	0.6990	1.7782
27	10	91.58	60	1.9618	1.0000	1.7782
28	25	106.23	60	2.0262	1.3979	1.7782
29	50	117.31	60	2.0693	1.6990	1.7782
30	75	123.79	60	2.0927	1.8751	1.7782
31	100	128.38	60	2.1085	2.0000	1.7782
32	125	131.95	60	2.1204	2.0969	1.7782
33	150	134.86	60	2.1299	2.1761	1.7782
34	175	137.33	60	2.1378	2.2430	1.7782

35	200	139.46	60	2.1445	2.3010	1.7782
36	250	143.03	60	2.1554	2.3979	1.7782
37	2	47.62	90	1.6778	0.3010	1.9542
38	5	58.20	90	1.7650	0.6990	1.9542
39	10	66.21	90	1.8209	1.0000	1.9542
40	25	76.80	90	1.8854	1.3979	1.9542
41	50	84.81	90	1.9284	1.6990	1.9542
42	75	89.49	90	1.9518	1.8751	1.9542
43	100	92.82	90	1.9676	2.0000	1.9542
44	125	95.40	90	1.9795	2.0969	1.9542
45	150	97.50	90	1.9890	2.1761	1.9542
46	175	99.28	90	1.9969	2.2430	1.9542
47	200	100.83	90	2.0036	2.3010	1.9542
48	250	103.41	90	2.0145	2.3979	1.9542
49	2	18.17	300	1.2595	0.3010	2.4771
50	5	22.22	300	1.3467	0.6990	2.4771
51	10	25.27	300	1.4026	1.0000	2.4771
52	25	29.31	300	1.4671	1.3979	2.4771
53	50	32.37	300	1.5101	1.6990	2.4771
54	75	34.16	300	1.5335	1.8751	2.4771
55	100	35.43	300	1.5493	2.0000	2.4771
56	125	36.41	300	1.5612	2.0969	2.4771
57	150	37.21	300	1.5707	2.1761	2.4771
58	175	37.89	300	1.5786	2.2430	2.4771
59	200	38.48	300	1.5853	2.3010	2.4771
60	250	39.47	300	1.5962	2.3979	2.4771
61	2	12.48	480	1.0962	0.3010	2.6812
62	5	15.25	480	1.1834	0.6990	2.6812
63	10	17.35	480	1.2393	1.0000	2.6812
64	25	20.13	480	1.3038	1.3979	2.6812
65	50	22.23	480	1.3468	1.6990	2.6812
66	75	23.45	480	1.3702	1.8751	2.6812
67	100	24.32	480	1.3860	2.0000	2.6812
68	125	25.00	480	1.3979	2.0969	2.6812
69	150	25.55	480	1.4074	2.1761	2.6812
70	175	26.02	480	1.4153	2.2430	2.6812
71	200	26.42	480	1.4220	2.3010	2.6812
72	250	27.10	480	1.4329	2.3979	2.6812
73	2	9.02	720	0.9553	0.3010	2.8573
74	5	11.03	720	1.0425	0.6990	2.8573
75	10	12.55	720	1.0985	1.0000	2.8573
76	25	14.55	720	1.1629	1.3979	2.8573
77	50	16.07	720	1.2060	1.6990	2.8573
78	75	16.96	720	1.2293	1.8751	2.8573
79	100	17.59	720	1.2452	2.0000	2.8573
80	125	18.07	720	1.2571	2.0969	2.8573
81	150	18.47	720	1.2665	2.1761	2.8573

82	175	18.81	720	1.2744	2.2430	2.8573
83	200	19.10	720	1.2811	2.3010	2.8573
84	250	19.59	720	1.2921	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	$Y*X_1$	$Y*X_2$	X_1*X_2	X_1^2	X_2^2
1	2	0.6200	3.0421	0.4447	0.0906	2.1819
2	5	1.5004	3.1709	1.0325	0.4886	2.1819
3	10	2.2026	3.2536	1.4771	1.0000	2.1819
4	25	3.1692	3.3487	2.0649	1.9542	2.1819
5	50	3.9249	3.4124	2.5096	2.8865	2.1819
6	75	4.3754	3.4469	2.7697	3.5159	2.1819
7	100	4.6987	3.4702	2.9542	4.0000	2.1819
8	125	4.9513	3.4878	3.0974	4.3970	2.1819
9	150	5.1589	3.5018	3.2144	4.7354	2.1819
10	175	5.3352	3.5134	3.3132	5.0312	2.1819
11	200	5.4886	3.5233	3.3989	5.2947	2.1819
12	250	5.7460	3.5395	3.5420	5.7501	2.1819
13	2	0.5776	3.1718	0.4977	0.0906	2.7331
14	5	1.4020	3.3160	1.1555	0.4886	2.7331
15	10	2.0618	3.4085	1.6532	1.0000	2.7331
16	25	2.9723	3.5150	2.3111	1.9542	2.7331
17	50	3.6855	3.5863	2.8088	2.8865	2.7331
18	75	4.1113	3.6249	3.0999	3.5159	2.7331
19	100	4.4169	3.6510	3.3064	4.0000	2.7331
20	125	4.6559	3.6707	3.4666	4.3970	2.7331
21	150	4.8523	3.6864	3.5975	4.7354	2.7331
22	175	5.0193	3.6994	3.7082	5.0312	2.7331
23	200	5.1644	3.7105	3.8041	5.2947	2.7331
24	250	5.4082	3.7286	3.9643	5.7501	2.7331
25	2	0.5475	3.2338	0.5353	0.0906	3.1618
26	5	1.3321	3.3889	1.2429	0.4886	3.1618
27	10	1.9618	3.4884	1.7782	1.0000	3.1618
28	25	2.8326	3.6030	2.4857	1.9542	3.1618
29	50	3.5157	3.6796	3.0210	2.8865	3.1618
30	75	3.9239	3.7211	3.3341	3.5159	3.1618
31	100	4.2170	3.7492	3.5563	4.0000	3.1618
32	125	4.4463	3.7704	3.7286	4.3970	3.1618
33	150	4.6348	3.7873	3.8694	4.7354	3.1618
34	175	4.7951	3.8012	3.9885	5.0312	3.1618
35	200	4.9344	3.8132	4.0916	5.2947	3.1618
36	250	5.1686	3.8327	4.2639	5.7501	3.1618
37	2	0.5051	3.2788	0.5883	0.0906	3.8191
38	5	1.2337	3.4492	1.3660	0.4886	3.8191
39	10	1.8209	3.5586	1.9542	1.0000	3.8191

40	25	2.6356	3.6845	2.7319	1.9542	3.8191
41	50	3.2764	3.7686	3.3202	2.8865	3.8191
42	75	3.6597	3.8143	3.6643	3.5159	3.8191
43	100	3.9353	3.8452	3.9085	4.0000	3.8191
44	125	4.1509	3.8685	4.0979	4.3970	3.8191
45	150	4.3283	3.8870	4.2526	4.7354	3.8191
46	175	4.4791	3.9024	4.3834	5.0312	3.8191
47	200	4.6103	3.9155	4.4968	5.2947	3.8191
48	250	4.8308	3.9369	4.6862	5.7501	3.8191
49	2	0.3791	3.1198	0.7457	0.0906	6.1361
50	5	0.9413	3.3358	1.7314	0.4886	6.1361
51	10	1.4026	3.4745	2.4771	1.0000	6.1361
52	25	2.0509	3.6341	3.4629	1.9542	6.1361
53	50	2.5657	3.7408	4.2086	2.8865	6.1361
54	75	2.8754	3.7986	4.6448	3.5159	6.1361
55	100	3.0987	3.8379	4.9542	4.0000	6.1361
56	125	3.2738	3.8674	5.1943	4.3970	6.1361
57	150	3.4180	3.8909	5.3904	4.7354	6.1361
58	175	3.5408	3.9103	5.5563	5.0312	6.1361
59	200	3.6478	3.9269	5.6999	5.2947	6.1361
60	250	3.8277	3.9541	5.9400	5.7501	6.1361
61	2	0.3300	2.9391	0.8071	0.0906	7.1891
62	5	0.8271	3.1729	1.8741	0.4886	7.1891
63	10	1.2393	3.3230	2.6812	1.0000	7.1891
64	25	1.8226	3.4957	3.7482	1.9542	7.1891
65	50	2.2882	3.6112	4.5553	2.8865	7.1891
66	75	2.5692	3.6738	5.0275	3.5159	7.1891
67	100	2.7721	3.7163	5.3625	4.0000	7.1891
68	125	2.9313	3.7482	5.6223	4.3970	7.1891
69	150	3.0627	3.7736	5.8346	4.7354	7.1891
70	175	3.1745	3.7947	6.0141	5.0312	7.1891
71	200	3.2720	3.8127	6.1696	5.2947	7.1891
72	250	3.4361	3.8421	6.4295	5.7501	7.1891
73	2	0.2876	2.7296	0.8601	0.0906	8.1643
74	5	0.7287	2.9787	1.9972	0.4886	8.1643
75	10	1.0985	3.1387	2.8573	1.0000	8.1643
76	25	1.6257	3.3228	3.9944	1.9542	8.1643
77	50	2.0489	3.4459	4.8545	2.8865	8.1643
78	75	2.3051	3.5126	5.3577	3.5159	8.1643
79	100	2.4903	3.5578	5.7147	4.0000	8.1643
80	125	2.6359	3.5918	5.9916	4.3970	8.1643
81	150	2.7561	3.6189	6.2178	4.7354	8.1643
82	175	2.8585	3.6414	6.4091	5.0312	8.1643
83	200	2.9479	3.6605	6.5748	5.2947	8.1643
84	250	3.0983	3.6919	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 149.355 $\quad \sum X_1 =$ 141.309

$\sum X_2 =$ 178.541 $\quad \sum Y * X_1 =$ 256.903

$\sum Y * X_2 =$ 300.543 $\quad \sum X_1 * X_2 =$ 300.350

$\sum X_1^{\,2} =$ 274.010 $\quad \sum X_2^{\,2} =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{\left(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}{\left(\sum (X_1 X_2) * \sum X_2 - \sum X_2^2 * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}$$

$C =$ -0.800000

$B =$ 0.1556754

$A =$ 3.21654713

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A =$ 1646.44464

$a = B =$ 0.1556754

$b = -C =$ 0.800000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

$\lambda =$ 1646.4

$\psi =$ 0.1556754

$\eta =$ 0.80

$\theta =$ 2.0

APLICACIÓN DE METODOLOGIAS PROPUESTAS

Metodologia Propuesta por:

El Modelo propuesto por Sherman (1931) USA

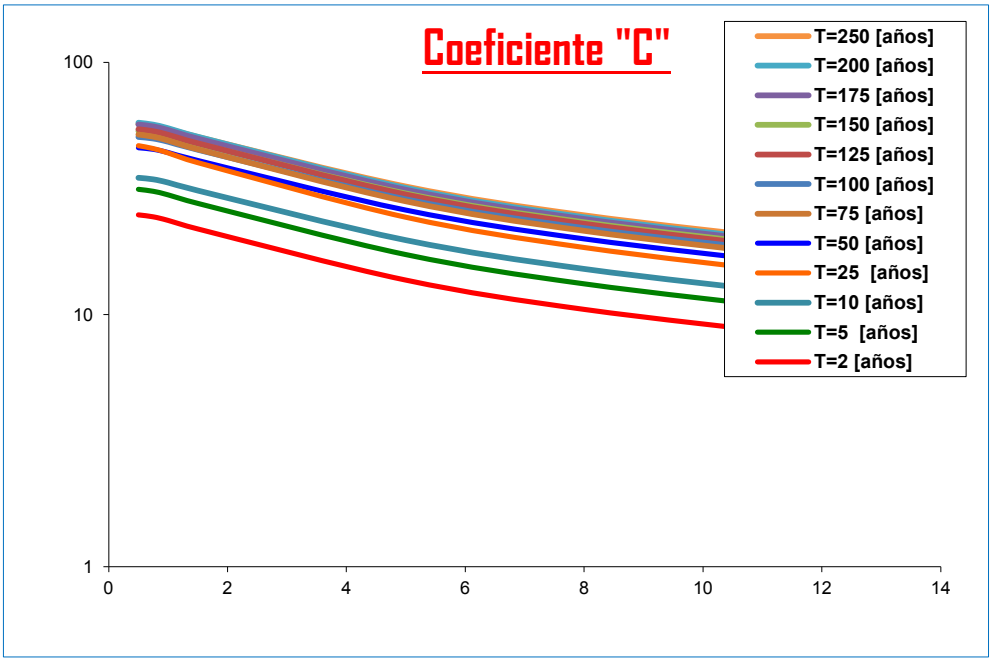
$$i = \frac{K * T_{\text{Re torno}}{}^{a}}{(D_{Duracion} + C)^{b}} \Leftrightarrow i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

Donde se procedera a determinar las constantes "c,b,a y K" para cada Ciudad

CALCULO DE "C"

Periodo de Retorno	Duracion de lluvia en (Hrs)						
	0.5	0.75	1	1.5	5	8	12
2	24.83	24.39	23.61	21.84	13.69	10.48	8.10
5	31.35	30.79	29.80	27.57	17.28	13.23	10.22
10	34.83	34.34	33.34	30.99	19.72	15.16	11.74
25	46.69	45.47	43.70	39.99	24.30	18.44	14.16
50	45.82	45.18	43.86	40.77	25.94	19.95	15.45
75	51.69	50.67	48.96	45.17	28.11	21.47	16.56
100	50.56	49.84	48.40	44.99	28.62	22.01	17.05
125	54.25	53.28	51.57	47.70	29.91	22.90	17.69
150	53.33	52.57	51.05	47.45	30.18	23.21	17.98
175	56.64	55.63	53.85	49.81	31.23	23.91	18.47
200	57.59	56.57	54.75	50.64	31.75	24.31	18.78
250	56.81	56.01	54.39	50.55	32.16	24.73	19.16

Periodo (T)	C (Adoptado)
2	1.9
5	1.9
10	2
25	1.7
50	2
75	1.85
100	2
125	1.9
150	2
175	1.9
200	1.9
250	2



K = Numero de Periodos considerados = 12 años

$$C = \frac{\sum C_i}{K} = 1.9208 \qquad \theta = \frac{\sum \theta_i}{K} = 2.0$$

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	i (mm/hrs)	Duracion (min)	Y = Log i	X1 = Log T	X2 = Log D
1	2	119.19	30	2.0762	0.3010	1.4771
2	5	150.48	30	2.1775	0.6990	1.4771
3	10	174.15	30	2.2409	1.0000	1.4771
4	25	205.44	30	2.3127	1.3979	1.4771
5	50	229.11	30	2.3600	1.6990	1.4771
6	75	242.96	30	2.3855	1.8751	1.4771
7	100	252.78	30	2.4027	2.0000	1.4771
8	125	260.40	30	2.4156	2.0969	1.4771
9	150	266.63	30	2.4259	2.1761	1.4771
10	175	271.89	30	2.4344	2.2430	1.4771
11	200	276.45	30	2.4416	2.3010	1.4771
12	250	284.07	30	2.4534	2.3979	1.4771
13	2	86.17	45	1.9354	0.3010	1.6532
14	5	108.79	45	2.0366	0.6990	1.6532
15	10	125.91	45	2.1001	1.0000	1.6532
16	25	148.53	45	2.1718	1.3979	1.6532
17	50	165.64	45	2.2192	1.6990	1.6532
18	75	175.65	45	2.2447	1.8751	1.6532
19	100	182.76	45	2.2619	2.0000	1.6532
20	125	188.27	45	2.2748	2.0969	1.6532
21	150	192.77	45	2.2850	2.1761	1.6532
22	175	196.57	45	2.2935	2.2430	1.6532
23	200	199.87	45	2.3007	2.3010	1.6532
24	250	205.38	45	2.3126	2.3979	1.6532
25	2	68.46	60	1.8354	0.3010	1.7782
26	5	86.43	60	1.9367	0.6990	1.7782
27	10	100.02	60	2.0001	1.0000	1.7782
28	25	118.00	60	2.0719	1.3979	1.7782
29	50	131.59	60	2.1192	1.6990	1.7782
30	75	139.54	60	2.1447	1.8751	1.7782
31	100	145.19	60	2.1619	2.0000	1.7782
32	125	149.56	60	2.1748	2.0969	1.7782
33	150	153.14	60	2.1851	2.1761	1.7782
34	175	156.16	60	2.1936	2.2430	1.7782
35	200	158.78	60	2.2008	2.3010	1.7782
36	250	163.16	60	2.2126	2.3979	1.7782

37	2	49.49	90	1.6945	0.3010	1.9542
38	5	62.49	90	1.7958	0.6990	1.9542
39	10	72.32	90	1.8592	1.0000	1.9542
40	25	85.31	90	1.9310	1.3979	1.9542
41	50	95.14	90	1.9784	1.6990	1.9542
42	75	100.89	90	2.0038	1.8751	1.9542
43	100	104.97	90	2.0210	2.0000	1.9542
44	125	108.13	90	2.0339	2.0969	1.9542
45	150	110.72	90	2.0442	2.1761	1.9542
46	175	112.90	90	2.0527	2.2430	1.9542
47	200	114.80	90	2.0599	2.3010	1.9542
48	250	117.96	90	2.0717	2.3979	1.9542
49	2	18.89	300	1.2762	0.3010	2.4771
50	5	23.85	300	1.3775	0.6990	2.4771
51	10	27.60	300	1.4409	1.0000	2.4771
52	25	32.56	300	1.5127	1.3979	2.4771
53	50	36.31	300	1.5600	1.6990	2.4771
54	75	38.51	300	1.5855	1.8751	2.4771
55	100	40.06	300	1.6027	2.0000	2.4771
56	125	41.27	300	1.6156	2.0969	2.4771
57	150	42.26	300	1.6259	2.1761	2.4771
58	175	43.09	300	1.6344	2.2430	2.4771
59	200	43.81	300	1.6416	2.3010	2.4771
60	250	45.02	300	1.6534	2.3979	2.4771
61	2	12.97	480	1.1129	0.3010	2.6812
62	5	16.38	480	1.2142	0.6990	2.6812
63	10	18.95	480	1.2776	1.0000	2.6812
64	25	22.36	480	1.3494	1.3979	2.6812
65	50	24.93	480	1.3968	1.6990	2.6812
66	75	26.44	480	1.4222	1.8751	2.6812
67	100	27.51	480	1.4395	2.0000	2.6812
68	125	28.34	480	1.4523	2.0969	2.6812
69	150	29.01	480	1.4626	2.1761	2.6812
70	175	29.59	480	1.4711	2.2430	2.6812
71	200	30.08	480	1.4783	2.3010	2.6812
72	250	30.91	480	1.4901	2.3979	2.6812
73	2	9.38	720	0.9721	0.3010	2.8573
74	5	11.84	720	1.0733	0.6990	2.8573
75	10	13.70	720	1.1368	1.0000	2.8573
76	25	16.16	720	1.2085	1.3979	2.8573
77	50	18.03	720	1.2559	1.6990	2.8573
78	75	19.11	720	1.2814	1.8751	2.8573
79	100	19.89	720	1.2986	2.0000	2.8573
80	125	20.49	720	1.3115	2.0969	2.8573
81	150	20.98	720	1.3217	2.1761	2.8573
82	175	21.39	720	1.3302	2.2430	2.8573
83	200	21.75	720	1.3375	2.3010	2.8573

84	250	22.35	720	1.3493	2.3979	2.8573

APLICACIÓN DEL METODO REGRESION MULTIPLE POR MINIMOS CUADRADOS

n	T (años)	Y*X1	Y*X2	X1*X2	X1^2	X2^2
1	2	0.6250	3.0669	0.4447	0.0906	2.1819
2	5	1.5220	3.2164	1.0325	0.4886	2.1819
3	10	2.2409	3.3101	1.4771	1.0000	2.1819
4	25	3.2330	3.4161	2.0649	1.9542	2.1819
5	50	4.0097	3.4861	2.5096	2.8865	2.1819
6	75	4.4730	3.5237	2.7697	3.5159	2.1819
7	100	4.8055	3.5491	2.9542	4.0000	2.1819
8	125	5.0654	3.5682	3.0974	4.3970	2.1819
9	150	5.2790	3.5834	3.2144	4.7354	2.1819
10	175	5.4604	3.5959	3.3132	5.0312	2.1819
11	200	5.6182	3.6066	3.3989	5.2947	2.1819
12	250	5.8832	3.6240	3.5420	5.7501	2.1819
13	2	0.5826	3.1996	0.4977	0.0906	2.7331
14	5	1.4235	3.3669	1.1555	0.4886	2.7331
15	10	2.1001	3.4718	1.6532	1.0000	2.7331
16	25	3.0361	3.5905	2.3111	1.9542	2.7331
17	50	3.7703	3.6688	2.8088	2.8865	2.7331
18	75	4.2089	3.7109	3.0999	3.5159	2.7331
19	100	4.5237	3.7394	3.3064	4.0000	2.7331
20	125	4.7700	3.7607	3.4666	4.3970	2.7331
21	150	4.9724	3.7776	3.5975	4.7354	2.7331
22	175	5.1445	3.7917	3.7082	5.0312	2.7331
23	200	5.2941	3.8036	3.8041	5.2947	2.7331
24	250	5.5454	3.8231	3.9643	5.7501	2.7331
25	2	0.5525	3.2637	0.5353	0.0906	3.1618
26	5	1.3537	3.4437	1.2429	0.4886	3.1618
27	10	2.0001	3.5565	1.7782	1.0000	3.1618
28	25	2.8963	3.6841	2.4857	1.9542	3.1618
29	50	3.6005	3.7683	3.0210	2.8865	3.1618
30	75	4.0215	3.8136	3.3341	3.5159	3.1618
31	100	4.3238	3.8442	3.5563	4.0000	3.1618
32	125	4.5604	3.8672	3.7286	4.3970	3.1618
33	150	4.7549	3.8854	3.8694	4.7354	3.1618
34	175	4.9203	3.9005	3.9885	5.0312	3.1618
35	200	5.0641	3.9133	4.0916	5.2947	3.1618
36	250	5.3057	3.9343	4.2639	5.7501	3.1618
37	2	0.5101	3.3116	0.5883	0.0906	3.8191
38	5	1.2552	3.5094	1.3660	0.4886	3.8191
39	10	1.8592	3.6334	1.9542	1.0000	3.8191
40	25	2.6994	3.7736	2.7319	1.9542	3.8191
41	50	3.3612	3.8662	3.3202	2.8865	3.8191

42	75	3.7573	3.9160	3.6643	3.5159	3.8191
43	100	4.0421	3.9496	3.9085	4.0000	3.8191
44	125	4.2650	3.9748	4.0979	4.3970	3.8191
45	150	4.4484	3.9949	4.2526	4.7354	3.8191
46	175	4.6043	4.0115	4.3834	5.0312	3.8191
47	200	4.7399	4.0256	4.4968	5.2947	3.8191
48	250	4.9679	4.0487	4.6862	5.7501	3.8191
49	2	0.3842	3.1614	0.7457	0.0906	6.1361
50	5	0.9628	3.4122	1.7314	0.4886	6.1361
51	10	1.4409	3.5693	2.4771	1.0000	6.1361
52	25	2.1146	3.7471	3.4629	1.9542	6.1361
53	50	2.6505	3.8644	4.2086	2.8865	6.1361
54	75	2.9730	3.9276	4.6448	3.5159	6.1361
55	100	3.2055	3.9702	4.9542	4.0000	6.1361
56	125	3.3879	4.0021	5.1943	4.3970	6.1361
57	150	3.5381	4.0276	5.3904	4.7354	6.1361
58	175	3.6660	4.0486	5.5563	5.0312	6.1361
59	200	3.7774	4.0665	5.6999	5.2947	6.1361
60	250	3.9648	4.0957	5.9400	5.7501	6.1361
61	2	0.3350	2.9841	0.8071	0.0906	7.1891
62	5	0.8487	3.2555	1.8741	0.4886	7.1891
63	10	1.2776	3.4256	2.6812	1.0000	7.1891
64	25	1.8864	3.6180	3.7482	1.9542	7.1891
65	50	2.3730	3.7450	4.5553	2.8865	7.1891
66	75	2.6668	3.8134	5.0275	3.5159	7.1891
67	100	2.8789	3.8595	5.3625	4.0000	7.1891
68	125	3.0454	3.8941	5.6223	4.3970	7.1891
69	150	3.1828	3.9216	5.8346	4.7354	7.1891
70	175	3.2997	3.9444	6.0141	5.0312	7.1891
71	200	3.4017	3.9637	6.1696	5.2947	7.1891
72	250	3.5733	3.9954	6.4295	5.7501	7.1891
73	2	0.2926	2.7775	0.8601	0.0906	8.1643
74	5	0.7502	3.0668	1.9972	0.4886	8.1643
75	10	1.1368	3.2481	2.8573	1.0000	8.1643
76	25	1.6894	3.4531	3.9944	1.9542	8.1643
77	50	2.1337	3.5885	4.8545	2.8865	8.1643
78	75	2.4026	3.6613	5.3577	3.5159	8.1643
79	100	2.5972	3.7105	5.7147	4.0000	8.1643
80	125	2.7500	3.7473	5.9916	4.3970	8.1643
81	150	2.8762	3.7766	6.2178	4.7354	8.1643
82	175	2.9838	3.8009	6.4091	5.0312	8.1643
83	200	3.0775	3.8215	6.5748	5.2947	8.1643
84	250	3.2354	3.8553	6.8517	5.7501	8.1643

De la presente tabla de calculos obtenemos los siguientes resultados:

$\sum Y =$ 153.316 $\quad \sum X_1 =$ 141.309

$\sum X_2 =$ 178.541 $\quad \sum Y * X_1 =$ 264.211

$\sum Y * X_2 =$ 308.962 $\quad \sum X_1 * X_2 =$ 300.350

$\sum X_1^{\,2} =$ 274.010 $\quad \sum X_2^{\,2} =$ 400.625

$n =$ 84

Formando un sistema de 3 ecuaciones con 3 incognitas tenemos:

$$\sum Y = A*n + B*\sum X_1 + C*\sum X_2$$

$$\sum X_1 * Y = A*\sum X_1 + B*\sum X_1^{\,2} + C*\sum (X_1 * X_2)$$

$$\sum X_2 * Y = A*\sum X_2 + B*\sum (X_1 * X_2) + C*\sum X_2^{\,2}$$

Por lo tanto las constantes seran:

$$C = \frac{\left(\sum X_1 Y * \sum X_2 - \sum X_2 Y * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum Y * \sum X_1 - \sum X_1 Y * \sum X_2\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}{\left(\sum (X_1 X_2) * \sum X_2 - \sum X_2^2 * \sum X_1\right) * \left(\left(\sum X_1\right)^2 - \sum X_1^2 * n\right) - \left(\sum X_2 * \sum X_1 - \sum (X_1 X_2) * n\right) * \left(\sum X_1^2 * \sum X_2 - \sum (X_1 X_2) * \sum X_1\right)}$$

$C =$ -0.800000

$B =$ 0.1734531

$A =$ 3.23379427

En funcion a estos parametros Calculados se determinan las constantes a,b y k

$K = 10^A =$ 1713.14559

$a = B =$ 0.1734531

$b = -C =$ 0.800000

Por lo tanto los Coeficientes para el Modelo de Sherman son:

$$i = \frac{\lambda * T^{\psi}}{(d + \theta)^{\eta}}$$

$\lambda =$ 1713.1

$\psi =$ 0.1734531

$\eta =$ 0.80

$\theta =$ 2.0