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Methodology for the calculation of RMP Curves (Repetition, Magnitude, Persistence)

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--***ABSTRACT***--
The following mathematical calculation work analyzes the construction of the Repetition-Magnitude-Persistence (RPM) curve, with numerical data of maximum annual intensities, collected in a 48-year time series, from the León station, Nicaragua; code 64043, latitude 12°25´36" and longitude 86°54´48", elevation 60 msnm, type HMP.

The methodology consisted of a sampling on the respective pluviograms, in order to obtain the maximum intensities per year, for persistence of 5, 10, 15, 30, 60, 120 and 360 minutes. The data were taken to hourly quantities with multiple linear regression. The RPM curves were then constructed for return periods of 5, 10, 15, 20, 30, 50 and 100 years.

Thus, it can be pointed out that the RPM curves obtained for the León station are similar with others that can be generated for the studied area.

Keywords:*Return period, magnitude, persistence, repetition, regression*

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I. INTRODUCTION

This research attempted to analyze the design and construction of the new Repetition-Magnitude-Persistence (RPM) curves for the city of León, Nicaragua. For this, the main HMP station in León was used.

The area of application of the Repetition-Magnitude-Persistence (RPM) curves is characterized by presenting a tropical climate. Summers here have a fair amount of rain, while winters have very little. This climate is considered Aw according to the Koppen-Geiger classification. The average temperature in León is 26.8 ° C. In a year the precipitation is 1526 mm.

Thedriestmonthis March. Thereis 0 mm ofprecipitation in March. Mostoftheprecipitationherefalls in Octoberaveraging 340 mm.

With an average of 28.4 ° C, April is the warmest month. December is the coldest month, with an average temperature of 25.5 ° C.

With all of the above, the research seeks to carry out a new modulation of the IDF curves to RPM curves, with a finished study and analysis of the behavior of the precipitation of the station in question in the department of León, allowing to provide patterns of behavior and the possibility of have effective and efficient indicators for hydrological design.

II. OBJECTIVE

Develop a modelforthecalculationof RPM curves usingthemultiple linear regressionmethod, in thecontextofclimatechange.

III. METHODOLOGY

3.1 General

In the first instance, a distinction will be made between the IDF curves and the RPM curves, sharing the acronyms and advantages of the new methodology.

The IDF curves, Intensity-Duration-Frequency, are curves that result from joining the representative points of the average intensity in intervals of different duration, and all corresponding to the same frequencyorreturnperiod(Témez, 1978).

According,et al (1994),intensityisdefined as the temporal rateofprecipitation, thatis, thedepth per unitof time (mm / hr), and thisisexpressed as(1):

$$I = \frac{P}{T_d} \text{Equation(1)}$$

Where:

P = is the depth of rain in mm
Td = storm time in hr

One of the methods for calculating IDF curves is the one that simultaneously relates the intensity, duration and return period in a family of curves, the equation of which is:

$$I = \frac{K * T^m}{t_c^n} \text{Equation(2)}$$

Where:
I = intensity in mm / hr
T = return period in years
tc = concentration time in hr
K, m, n = adjustment coefficient

3.2 LogicHydrometeorStationSelection

In the case ofthe IDF curves, somesteps are followedtoconstructthem, forthisitisnecessarytoselectthemainhydrometeorologicalstation in thearea, in thisselectionthetype, quantity and periodicityofthe data must be taken as a criterion, taking as referencetheanalysis in therequiredperiod.

3.3 Collection of the required information

The hydrometeorological data necessary for the development of these correspond to the rain gauge bands with the records of daily and hourly rainfall.

3.4 Determinationof máximum intensities

This stage analyzes the rain gauge recording bands, for which various samplings are carried out. It starts with measurements from 08:00 hr in the morning of one day to 08:00 hr the next day, for a duration of 24 hours; then, it is necessary to move in a time interval in a discreet and stable way, using keys to do so, in order to select for each year the extreme values of precipitation for times of 1, 2, 6, 8, 12 and 24 hours, then the values of each of the series are taken and divided by duration D in (hours), thus obtaining the intensity in mm / hr.

Table1:*Date ofheightmaximunofprecipitation in (mm) in a given time.*
Font: Ownelaboration. (2020).

AÑOS	5	10	15	30	60	120	360
1971	157.4	131.2	110.5	81.9	55.7	32.7	13.4
1972	157.4	131.2	110.5	81.9	55.7	32.7	13.4
1973	157.4	131.2	110.5	81.9	55.7	32.7	13.4
1974	162.0	153.0	144.0	120.6	80.2	47.0	32.9
1975	154.8	148.8	133.6	78.8	63.2	37.5	12.7
1976	136.8	109.2	97.2	72.8	61.7	23.7	12.4
1977	183.6	170.4	117.2	65.0	37.1	25.7	2.2
1978	186.0	171.6	156.8	130.2	54.8	33.4	11.7
1979	122.4	120.0	99.6	81.2	51.9	35.3	23.0
1980	234.6	176.4	130.4	88.4	61.9	36.7	9.2
1981	153.6	136.8	121.6	116.2	82.6	42.6	12.0
1982	201.6	147.6	117.6	85.6	64.6	53.2	33.5
1983	240.0	168.0	124.0	91.0	48.0	25.5	9.2
1984	240.0	138.0	116.0	82.0	44.0	18.4	8.3
1985	118.8	114.0	92.0	69.0	64.2	34.2	12.0
1986	116.4	77.4	71.6	54.0	34.0	23.3	8.5
1987	121.2	121.2	102.1	80.8	67.7	36.5	13.0
1988	129.6	124.2	110.4	75.0	57.0	47.6	20.6
1989	141.6	117.6	91.2	73.2	41.7	16.1	6.0
1990	189.6	135.0	113.6	92.2	58.5	31.1	8.4
1991	206.4	138.0	119.2	76.0	52.6	31.3	13.9
1992	116.4	94.8	79.2	76.0	60.0	33.5	16.4
1993	160.8	145.8	125.2	65.2	50.6	36.9	25.9
1994	122.4	122.4	120.0	85.2	56.0	30.7	11.5
1995	120.0	118.8	87.2	60.0	37.8	24.0	1.6
1996	96.0	84.0	80.0	68.8	42.5	22.2	0.9
1997	144.0	120.0	95.6	57.0	48.7	28.2	16.6
1998	220.8	110.4	90.8	60.6	37.6	11.8	0.0
1999	154.8	144.6	123.6	98.8	54.3	28.7	8.3
2000	228.0	156.0	134.4	81.4	54.0	40.0	23.3
2001	96.0	60.0	56.0	49.2	47.2	29.6	0.0
2002	198.0	152.4	120.4	86.8	61.3	37.6	17.6
2003	183.6	117.6	96.8	88.4	51.5	7.6	2.5
2004	96.0	84.0	70.4	41.8	24.7	18.7	0.0
2005	150.0	135.0	120.4	102.0	56.2	29.8	21.5
2006	234.0	163.8	125.6	73.0	37.0	32.8	10.4
2007	228.8	181.8	156.4	117.6	78.7	42.5	14.4
2008	144.0	120.0	106.0	84.0	68.0	49.2	19.5
2009	190.8	175.2	116.0	94.6	75.6	34.4	13.0
2010	229.2	166.8	148.0	118.2	76.5	44.6	15.4
2011	159.6	157.2	124.8	81.2	59.8	19.4	8.7
2012	146.4	118.8	88.0	76.4	61.8	38.2	3.3
2013	224.4	196.8	127.6	85.8	52.1	27.2	11.7
2014	152.4	100.2	88.8	88.0	46.3	30.1	13.0
2015	141.6	120.0	102.0	67.6	45.2	20.8	9.1
2016	152.4	199.4	144.0	80.0	52.5	22.9	7.4
2017	228.0	140.4	132.4	91.8	53.7	32.0	18.1
2018	177.6	117.6	94.4	76.0	45.8	40.7	12.7
Maxima	**240.0**	**199.4**	**156.8**	**130.2**	**82.6**	**53.2**	**33.5**

Depending on the methodology proposed by Témez, each maximum hourly precipitation height is divided by its duration in hours, obtaining the maximum annual precipitation intensities in mm / hr for each duration.

3.5 Fitting the data tothe Gumbel probabilitydistributionfunction

The next methodological step corresponds to the adjustment of the precipitation intensity values to the Gumbel probability distribution function (Pizarro, 1986).

$$F(X) = IP[\mathrm{E} \leq X] = e^{-e^{-\sigma(X-\mu)}}$$ Equation(3)

Where; X is the value to be assumed by the random variable and σ, μ are parameters to be estimated based on the sample values.

The Determination Coefficient (R^2) and the Kolmogorov-Smirnov Test are used as a measure of goodness of fit.

3.6 Determinationof IDF curves for different periods of Tr

After adjustingwiththe Gumbel probability distribution function, the precipitation intensity and duration are plotted, in order to obtain the points of the curve associated with a return period of 5 years. Then, the same operation is repeated with the return period T = 5, 10, 20, 30, 50, ..., 100 years, and for each of the pluviometric stations.

3.7 Definition of practical use tables

At this stage we proceed to the construction of tables, which account for the relationship between the intensity of precipitation at 1, 2, 4, 6, 8, 12 hr, and the intensity of 24 hr, and this for each return period considered. This, because 24-hour precipitation is the most common to find and these relationships would allow extrapolation to areas without data.

3.8 Statistic analysis

Once thepractical use tables have been defined and the IDF curves have been designed for each station, the behavior of the variables involved in this study is analyzed, simultaneously relating the three variables in a family of curves, in order to represent the relationship of the intensity, duration and frequency not only graphically, but also analytically, for which equation (2) proposed by Aparicio (1997) is used.

3.9 Development of RPM curves

In a simpler and more synthesizedway, theprolongationofthe RPM curves for a designstormisclarified in a systematizedprocedure in whichtheinteractionof a repetitionwithmagnitude and persistenceisbroughttogether. Beingableto define the RPM curves as theresultofjoiningtherepresentativepointsofthemaximumintensity in persistenceintervals, and allofthemcorrespondingtothesamerepetitionorreturnperiod, forwhichtheexpression (2) ishomologated in thefollowing:

$$M = \frac{K*T^m}{P_c^n} \text{Equation(3)}$$

Where:
M = isthemagnitude in mm / hr
T = returnperiod in years
Pc = concentration time in minutes orhours
K, m, n = are dimensionlessfitcoefficient

3.10 Potential regression

Fromthepreviousequationoflogarithmappliestoeachterm so itisobtained:

$$d = KT^m \text{ Equation (4)}$$
$$M = \frac{d}{t^n} = dPc^{-n} \text{Equation(5)}$$

Characteristic equation of potential regression

$$y = a * x^b \text{Equation(6)}$$

$$logM = \log(dPc^{-n})$$
$$logM = \log(d) + \log(Pc^{-n})$$
$$logM = \log(d) + (-n)\log(Pc) \text{Equation(7)}$$

Model estimatorsorfitestimators

$$b = \frac{\sum logX * \sum logY - \frac{\sum logX * \sum logY}{n}}{\sum (logX)^2 - \frac{(\sum logX)^2}{n}} \text{Equation(8)}$$

$$\log(a) = \frac{\sum logY - b * \sum logX}{n} \text{Equation(9)}$$

Approving adjustmentestimatorswehave:

a =	d
b =	-n

Depending on the variable change, another power regression is performed, resulting in the following equations:

$$b = \frac{\sum logX * \sum logY - \frac{\sum logX * \sum logY}{n}}{\sum (logX)^2 - \frac{(\sum logX)^2}{n}} \text{Equation(10)}$$

$$\log(a) = \frac{\sum logY - b*\sum logX}{n} \text{Equation(11)}$$

a =	K
b =	m

IV. RESULTS AND DISCUSSION

4.1 Selected data fromthe HMP station in León

Table2:*Annual máximum rainfallinstensities in mm.*
Font: INETER. (2020).

AÑOS	5	10	15	30	60	120	360
1971	157.4	131.2	110.5	81.9	55.7	32.7	13.4
1972	157.4	131.2	110.5	81.9	55.7	32.7	13.4
1973	157.4	131.2	110.5	81.9	55.7	32.7	13.4
1974	162.0	153.0	144.0	120.6	80.2	47.0	32.9
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1978	186.0	171.6	156.8	130.2	54.8	33.4	11.7
1979	122.4	120.0	99.6	81.2	51.9	35.3	23.0
1980	234.6	176.4	130.4	88.4	61.9	36.7	9.2
1981	153.6	136.8	121.6	116.2	82.6	42.6	12.0
1982	201.6	147.6	117.6	85.6	64.6	53.2	33.5
1983	240.0	168.0	124.0	91.0	48.0	25.5	9.2
1984	240.0	138.0	116.0	82.0	44.0	18.4	8.3
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1986	116.4	77.4	71.6	54.0	34.0	23.3	8.5
1987	121.2	121.2	102.1	80.8	67.7	36.5	13.0
1988	129.6	124.2	110.4	75.0	57.0	47.6	20.6
1989	141.6	117.6	91.2	73.2	41.7	16.1	6.0
1990	189.6	135.0	113.6	92.2	58.5	31.1	8.4
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1992	116.4	94.8	79.2	76.0	60.0	33.5	16.4
1993	160.8	145.8	125.2	65.2	50.6	36.9	25.9
1994	122.4	122.4	120.0	85.2	56.0	30.7	11.5
1995	120.0	118.8	87.2	60.0	37.8	24.0	1.6
1996	96.0	84.0	80.0	68.8	42.5	22.2	0.9
1997	144.0	120.0	95.6	57.0	48.7	28.2	16.6
1998	220.8	110.4	90.8	60.6	37.6	11.8	0.0
1999	154.8	144.6	123.6	98.8	54.3	28.7	8.3
2000	228.0	156.0	134.4	81.4	54.0	40.0	23.3
2001	96.0	60.0	56.0	49.2	47.2	29.6	0.0
2002	198.0	152.4	120.4	86.8	61.3	37.6	17.6
2003	183.6	117.6	96.8	88.4	51.5	7.6	2.5
2004	96.0	84.0	70.4	41.8	24.7	18.7	0.0
2005	150.0	135.0	120.4	102.0	56.2	29.8	21.5
2006	234.0	163.8	125.6	73.0	37.0	32.8	10.4
2007	228.8	181.8	156.4	117.6	78.7	42.5	14.4
2008	144.0	120.0	106.0	84.0	68.0	49.2	19.5
2009	190.8	175.2	116.0	94.6	75.6	34.4	13.0
2010	229.2	166.8	148.0	118.2	76.5	44.6	15.4
2011	159.6	157.2	124.8	81.2	59.8	19.4	8.7
2012	146.4	118.8	88.0	76.4	61.8	38.2	3.3
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2016	152.4	199.4	144.0	80.0	52.5	22.9	7.4
2017	228.0	140.4	132.4	91.8	53.7	32.0	18.1
2018	177.6	117.6	94.4	76.0	45.8	40.7	12.7
Maxima	**240.0**	**199.4**	**156.8**	**130.2**	**82.6**	**53.2**	**33.5**

4.2 DevelopmentoftheRepetition-Magnitude-Persistence (RPM) curve

For the construction of the RPM graph, the statistical coefficients, mean, standard deviation, alpha and beta will be calculated.

Table3:*calculationofstatisticalparameters.*
Font: ownelaboration. (2020).

	5	10	15	30	60	120	360
Media	166.8	134.7	111.3	81.9	54.8	31.5	12.3
Desviación	42.4	30.1	22.4	18.1	12.4	9.6	7.7
Alfa α	0.030	0.043	0.057	0.071	0.104	0.133	0.167
Beta β	147.747	121.116	101.252	73.774	49.186	27.153	8.891

$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$Equation to determine the mean(12)

$\sigma = \sqrt{\frac{\sum_{1}^{n}(X_i - \bar{X})^2}{n}}$Equationfordetermining standard deviation (13)

$\alpha = \frac{1}{0.779696 * \sigma}$Equation to determine the Alpha parameter (14)

$\beta = \bar{X} - 0.450047 * \sigma$Equationto determine the beta parameter (15)

Calculation of the intensities in mm / h for 24 hours, is performed from equation 3.

Table4:*calculationoftheintensityofapproachbasedonthePc y TR.*
Font: Ownelaboration. (2020).

TR	Pc						
	5	10	15	30	60	120	360
5	197.30	156.37	127.43	95.00	63.65	38.41	17.87
10	222.09	174.00	140.52	105.62	70.89	44.04	22.36
15	236.07	183.95	147.91	111.61	74.97	47.22	24.89
20	245.87	190.92	153.09	115.80	77.83	49.44	26.67
30	259.55	200.65	160.31	121.66	81.82	52.55	29.15
50	276.65	212.81	169.35	128.99	86.82	56.43	32.24
100	299.71	229.22	181.53	138.86	93.55	61.67	36.42

Calculation of the estimators of the adjustment is made for each return repetition, that is, for 5, 10, 15, 20, 30, 50 and 100 years.

Table5: *calculationoftheadjustmentestimatorsforthereturn periodo of 5 years.*
Font: ownelaboration. (2020).

PERIODO DE RETORNO 5 AÑOS							
	X	Y					
Pc (min)	tc (hr)	I (mm/hr)	LOGX	LOGY	(LOGX)2	(LOGY)2	LOGX*LOGY
5	0.083	197.30	0.6990	2.2951	0.489	5.268	1.604
10	0.167	156.37	1.0000	2.1942	1.000	4.814	2.194
15	0.250	127.43	1.1761	2.1053	1.383	4.432	2.476
30	0.500	95.00	1.4771	1.9777	2.182	3.911	2.921
60	1.000	63.65	1.7782	1.8038	3.162	3.254	3.207
120	2.000	38.41	2.0792	1.5844	4.323	2.510	3.294
360	6.000	17.87	2.5563	1.2521	6.535	1.568	3.201
		Σ	10.766	13.213	19.073	25.757	18.898

Table6:*Summary of estimators foradjustmentforthedifferentreturnperiods.*
Font: ownelaboration. (2020).

Calculationoffitestimators			
TR (years)	b=-n	Log(a)	d=a = $10^{log(a)}$
5	-0.565	2.7571	571.671
10	-0.543	2.7785	600.416
15	-0.532	2.7902	616.928
20	-0.527	2.8009	632.196

30	-0.520	2.8140	651.622
50	-0.511	2.8305	676.911
100	-0.502	2.8526	712.119

Table7:*Summaryofestimatorsfordifferentreturnperiodsforpotentialregression*
Font: ownelaboration(2020).

TR AÑOS	Termino constante de regresión	Coeficiente de regresión (n)
5	571.671	-0.565
10	600.416	-0.543
15	616.928	-0.532
20	632.196	-0.527
30	651.622	-0.520
50	676.911	-0.511
100	712.119	-0.502
Promedio	637.409	-0.529

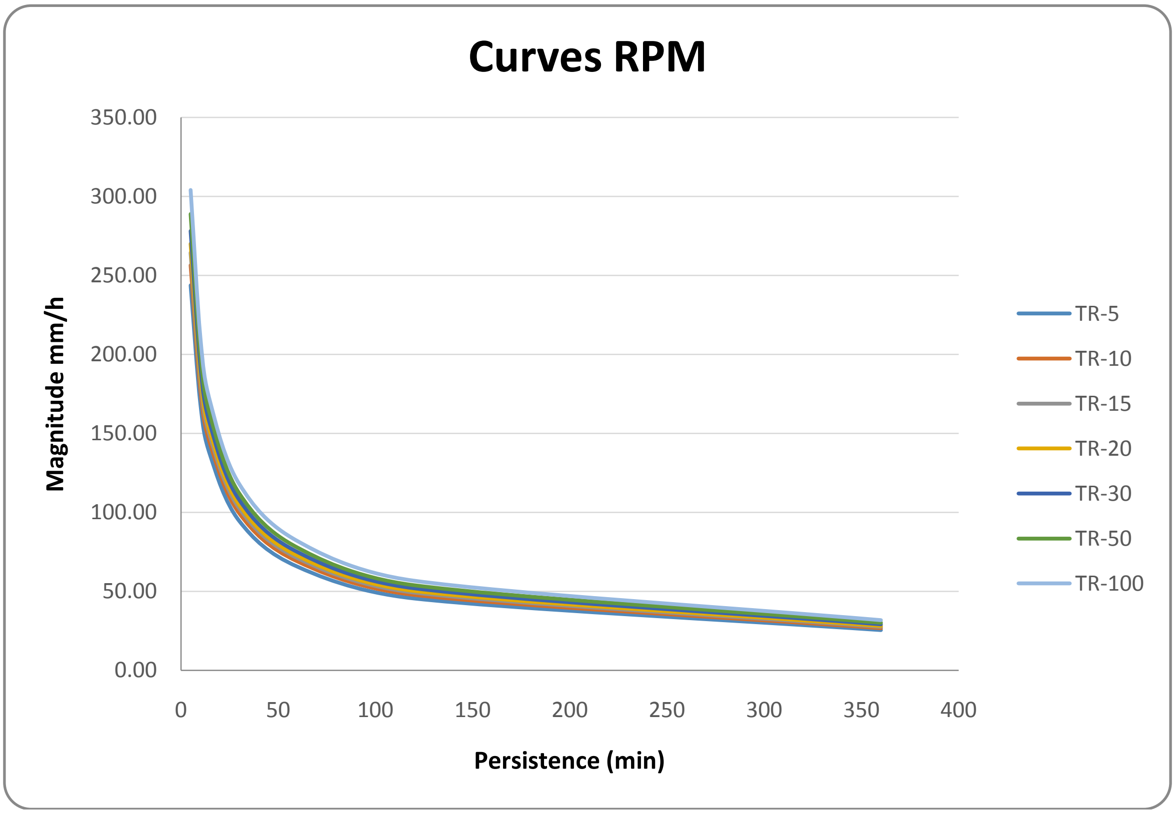
Table8:*Calculationoftheadjustmentestimatorsfordifferentreturnperiods, usingpotentialregression*
Font:ownelaboration. (2020).

Regresión potencial						
N°	X	Y	LOGX	LOGY	LOGX*LOGY	LOGX2
1	5	571.671	0.699	2.7571	1.9272	0.4886
2	10	600.416	1.000	2.7785	2.7785	1.0000
3	15	616.928	1.176	2.7902	3.2816	1.3832
4	20	632.196	1.301	2.8009	3.6440	1.6927
5	30	651.622	1.477	2.8140	4.1566	2.1819
6	50	676.911	1.699	2.8305	4.8090	2.8865
7	100	712.119	2.000	2.8526	5.7051	4.0000
Σ	230.000	4461.864	9.352	19.624	26.302	13.633
b=m	0.074					
loga=k	2.705	506.706				

Table9:*Adjustment estimatorsforcalculatingthe máximum magnitudefordifferentreturnperiods*
Font: ownelaboration(2020).

Calculationoffitestimators			
b=m	Log(a)	K=a = $10^{log(a)}$	n
0.074	2.705	506.706	-0.529

4.3 RPM curves withpotential regression methodology



Graph1: Representationofthe RPM curves.
Font: ownelaboration. (2020).

V. CONCLUSION

Based on the results obtained, the following conclusions are proposed:
The potential regression methodology for the estimation of the RPM curves was developed, in which the following terms can be homologated: Intensity equals Magnitude; Duration equals Persistence; and Frequency equals Repetition, so IDF curves are like saying RPM curves.
The model used to explain the relationship of Repetition, Persistence and Magnitude, have a very good quality of fit, which ensures a good estimate and forecast of maximum precipitation magnitudes.
Regarding the construction of the RPM curves, it can be said that, in general, there were no major problems in the design and development of the same for the station used.

VI. RECOMMENDATIONS

The use of the adjusted model is recommended for the stations that you want to develop the RPM curves, with this the model is validated.
To use the rational equation, it is possible to directly use the maximum intensity values for various time durations and for the different return periods established in the practical use table.
And finally, it is recommended that this study be complemented and reviewed within a maximum period of 8 years, in order to add new information, which could modify its results.

VII. GRATITUDE

First, I expressmythankstomymotherwho has been a personwho has managedto induce thisdeadly simple, bytheshiningpathtoachieveitsobjectives and goals; who, despitehisillness, has left traces ofthegreatfaiththat has tocontinueeducatingmyself, and thatwithout basilar has given me thebestthing a personmaywishtohave and isthegreatesttreasurethat can exist in theuniverse, "theknowledge". Thankyou, Madame Beatriz Picado.
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VIII. FINANCING

Ownfinancing

BIBLIOGRAPHY

[1]. Aparicio, F. 1997. Fundamentos de Hidrología de Superficie. Balderas, México: Limusa. 303 p.
[2]. Chen,C. L. 1983. " Rainfallintensity-duration-frequencyformulas,"J. Hydro. Engrg., ASCE, 109(12), 1603-1621 p.
[3]. Chow, V.; Maidment, D.; Mays, L. 1994. Manual de Hidrología Aplicada. Santafé de Bogotá, Colombia: Mc Graw-Hill. 584 p.
[4]. Cid, L.; Mora, C.; Valenzuela, M. 1990. Estadística matemática. Probabilidades e Inferencia estadística. Universidad de Concepción. Facultad de Ciencias. Departamento de matemáticas. Chile. 319 p.
[5]. Dickinson, T. 1977. " Rainfallintensity - frequencyrelationshipsfrommonthly extremes,". J. Hydro,. 35: 137-145 p.
[6]. Kazmann, R. 1974. Hidrología Moderna. Segunda Edición. Compañía Editorial Continental S.A.D.F. México. 420 p.
[7]. Linsley, R.; Kohler, M.; Paulhus, J. 1988. Hidrología para Ingenieros. Segunda Edición. Mc Graw-Hill. Latinoamericana. D.F. México. 386 p.
[8]. Mendenhall, W.; Scheaffer, R.; Wackerly, D. 1986. Estadística y Matemáticas con Aplicaciones. México: Editorial Iberoamericana, S.A. Tercera edición. 751 p.
[9]. Pizarro, R.; Novoa, P. 1986. Instructivo n° 5. Determinación de valores probabilísticos para variables hidrológicas. Elementos técnicos de Hidrología. Corporación Nacional Forestal (CONAF). Chile. 78 p.
[10]. Pizarro, R. 1993. Elementos técnicos de hidrología III. Proyecto regional mayor sobre uso y conservación de recursos hídricos en áreas rurales de América latina y el Caribe. Universidad de Talca. Talca. Chile. 135 p.
[11]. Ramírez, C. 1998. Análisis comparativo de modelos para la estimación de precipitaciones anuales en períodos extremos. Tesis para optar al título de Ingeniero Forestal. Universidad de Talca. Talca. Chile. 78 p.
[12]. Témez, J. 1978. Calculo Hidrometeorológico de Caudales máximos en pequeñas cuencas naturales. Dirección General de Carreteras. Madrid. España. 111p.

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