Hydrologic Condition ➔ G = Good, R= Regular, P= Poor.

Table 5. CN values classified by slope-HSG and hydrological condition-HSG

Sub basins	IF	MF	OU	St	Ag	SuAg	PFV
Hydrological condition-HSG							
Indio river	60	55	84	86	61	79	-
Highlands Pacora river	60	55	84	86	61	79	-
Midland and lowlands Pacora river	60	55	84	86	61	79	-
Cabobre river	60	55	84	86	61	79	-
Tatare river	60	55	84	86	61	79	-
Slope-HSG							
Indio river	70	70	-	-	64	82	10
Highlands Pacora river	66	66	-	-	61	79	5
Midland and lowlands Pacora river	66	66	-	-	61	79	5
Cabobre river	66	66	-	-	61	79	5
Tatare river	66	66	-	-	61	79	5

Table 6. Resulting CN values

Sub basins	IF	MF	OU	St	Ag	SuAg	PFV
Indio river	65	62	84	86	64	82	10
Highlands Pacora river	63	60	84	86	61	79	5
Midland and lowlands Pacora river	63	60	84	86	61	79	5
Cabobre river	63	60	84	86	61	79	5
Tatare river	63	60	84	86	61	79	5

Table 7. CN values by sub basins

Sub cuencas	CN X Area (%)							CN
	IF	MF	OU	St	Ag	SuAg	PFV	
Indio river	11.8	13.5	0.0	12.5	0.0	37.4	0.0	75
Highlands Pacora river	12.2	31.7	0.0	7.4	0.0	15.2	0.0	66
Midland and lowlands Pacora river	8.1	1.7	0.2	14.4	26.7	18.1	0.0	69
Cabobre river	10.1	15.9	0.0	11.4	3.5	30.3	0.0	71
Tatare river	18.1	2.9	0.1	8.9	25.5	11.1	0.0	67

3.2.3. Johnston and Cross

The t_c and t_p values obtained with this equation are shown in Table 8. The values for S and L employed in these calculation were obtained from Table 2.

Table 8. t_c and t_p values employing the equation from Johnston and Cross.

Sub basins	S (ft/mile)	t_c (hr)	t_p (hr)
Indio river	297	0.67	0.47
Highlands Pacora river	243	1.00	0.70
Midland and lowlands Pacora river	121	1.71	1.20
Cabobre river	262	1.00	0.70
Tatare river	164	1.23	0.86
Total	**130**	**2.01**	**1.41**

4. RESULTS

4.1. Kirpich Formula

A peak flow time in the Pacora river of 4.6 hours was obtained by employing two calculation approximations. First, by adding up t_p values (from table 2) for the upper and medium/lower sub-basins, and second by applying equations 1 and 2 to the entire basin. For the latest approach we used a L value equal to 50.29 Km (addition of the Stream lengths of the critical route) and a slope of 0.017. This slope was calculated by employing an elevation of 840 m, corresponding to the furthest point of the upper Pacora river basin.

4.2. SCS method

In Table 9, we show t_c and t_p values for each sub basin. Also, by employing the CN values and area estimates for each sub basin (Table 2), a weighted average for CN equal to 71 was estimated for the Pacora basin.

Table 9. t_c and t_p values employing the SCS equation.

Sub basin	Parameters			
	CN	S	t_c (hr)	t_p (hr)
Indio river	75	5.62	5.8	3.5
Highlands Pacora river	66	3.22	23.9	14.3
Midland and lowlands Pacora river	69	2.08	24.2	14.5
Cabobre river	71	4.94	12.8	7.7
Tatare river	67	3.47	15.8	9.5

Similar to the case of the Kiprich equation, the critical route is defined by the sum of the times corresponding to the upper Pacora River basin and the Middle and Lower Basin (the basin is employed here, not the river stream since this equation has area considerations, which Kiprich does not have). Thus from this method, we obtain a t_p equal to 28.8 hours. If we apply equation 3 directly for the whole basin, assuming a CN of 71 and an average slope (S) of 0.017 (1.7%), same as the one calculated for Kirpich, we get a t_p equal to 30.0 hr.

4.3. Johnston and Cross.

Repeating the above procedure, for Johnston and Cross a t_p = 2.71 hours was obtained. If we apply equation 4 directly for the whole basin, and assuming an L = 34 Km (21.2 Mi). which corresponds to the route of the furthest point from the upper Pacora River basin. (elevation 840 m), and a final elevation of 0, and an S = 130 feet / miles, a value of 2.01 hours is obtained

4.4. Comparison of models.

Table 10 shows the results obtained by the different methods employed. As expected, each one of them gave different results. However, we consider Kirprich and Johnston & Cross, may be the most appropriate for this basin. Kirprich because it is commonly used for smaller rural basins, and Johnston & Cross because it is model based on basins with area ranges within the Pacora scale. In the case of the SCS method, it is more applicable for basins of up to 800 Ha (Ven te Chow, 1994), even though it has the advantage that in the calculation of the CN, general aspects of topography, and land use are evaluated. It was also observed a small difference in the calculation of the concentration and peak times, using the basin as a whole or adding times from the critical route formed by main streams within the Pacora sub-basins. This addition was carried out under the logic that both Kirprich and to a greater extent the SCS method were developed for small basins, hence working at sub-basins level could improve the results accuracy.

Table 10. **Values of t_c and t_p values using different calculation methods**

Sub basins	Kirprich		SCS		Johnston / Cross	
	t_c (hr)	t_p (hr)	t_c (hr)	t_p (hr)	t_c (hr)	t_p (hr)
Indio river	1.3	0.9	5.8	3.5	0.67	0.47
Highlands Pacora river	3.1	2.2	23.9	14.3	1.00	0.70
Midland and lowlands Pacora river	3.4	2.4	24.2	14.5	1.71	1.20
Cabobre river	2.1	1.5	12.8	7.7	1.00	0.70
Tatare river	2.3	1.6	15.8	9.5	1.23	0.86
Pacora combined	**6.6**	**4.6**	**48.1**	**28.8**	**2.71**	**1.90**
Pacora as a whole	**6.6**	**4.6**	**50.2**	**30.0**	**2.01**	**1.41**

5. CONCLUSIONS

The existing empirical models for the estimation of the concentration and/or peak time were developed based on information from specific basins. Therefore, the use of a particular model must be done considering the characteristics of the basin to model with those employed originally by these models. In this work, we found little difference among concentration times, if this parameter was calculated by employing the basin as a whole or as the sum of sub-basin times within a critical flow path. Finally, It will require greater monitoring effort and the development of controlled experiments in basins with different areas, and characteristics to establish or validate already existing models and formulas. This is even more urgent in Tropical Basins, since historically these basins have been less studied and have less instrumentation than those in temperate zones.

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