

FREQUENCY OF DRY AND WET SPELLS IN SAN SALVADOR

by HEINZ DIETERICHS (*)

Summary — A study of the daily rainfall in San Salvador (El Salvador) has been made over a thirty year period 1918-47 in order to determine the dry and wet spells. It has been found that the extreme dry spells on the Pacific Coast of Central America last longer than in other climates, examined by HUTTON. The occurrence of a dry spell in San Salvador lasting over half a year is being minutely examined, and the cause of its origin traced to orographic effects during northerly winds.

Resumen — Se estudiaron las observaciones diaras de la precipitación en San Salvador (El Salvador), realizadas en los años 1918-47. Resulta que en la costa Pacifica Centroamericana los períodos secos duran más que los períodos más largos en los climas estudiados por HUTTON. Un período seco que duró más de medio año en San Salvador se analiza detenidamente, se supone que éste se habría originado en influencias orográficas efectivos cuando hay viento del norte.

Agriculture and hydrology are as interested in the heaviness of the rainfall, its intensity and seasonal distribution, as in the periods of successive dry and wet spells, as these are of importance to vegetation and the hydrology of rivers, especially in the tropics where they may end in a catastrophe.

HUTTON⁽¹⁾ recently reviewed the frequency of dry and wet spells in different climates, but because of the difficulty of finding daily data over a long period he was obliged to restrict his calculations to only six places in different latitudes, except for those in the tropics.

The following numbers will give some idea of the distribution of the dry and wet spells at the tropical station at San Salvador (El Salvador, Central America) (San Salvador, Observatorio Meteorológico Nacional: $\phi = 13^{\circ}42' N$, $\lambda = 89^{\circ}13' W$, $h = 682$ m).

1. Method.

In order to compare the Salvadorian data with the data of HUTTON⁽¹⁾ let us choose a thirty year period [San Salvador 1918-47 according to the Salvadorian Met. Yearbook⁽²⁾, i. e. without interruptions or reductions]. As usual ≥ 0.1 mm has been taken as a *rain day*, and < 0.1 mm as a *dry day*. Furthermore, the

(*) Dr. HEINZ DIETERICHS, Jefe meteorólogo en el Servicio Meteorológico Nacional de El Salvador, *San Salvador* (El Salvador, Central America).

divisions of spells into *continuous* and *broken* according to DIECKMANN [cit. by HUTTARY (1)] were used with the following definitions:

Continuous dry spell: is ended by the first rain day ≥ 0.1 mm, after a series of dry days.

Continuous wet spells: is ended by the first dry day occurring after a series of rain days.

Broken dry spell: is limited after a succession of dry days and rain days with < 1 mm, either when *one* day with ≥ 1 mm occurs or when on *three* successive days the precipitation of < 1 mm is measured.

Broken wet spell: consists of a series of rain days with scattered dry days, and is ended when at least *two* consecutive days follow with no appreciable precipitation.

In this paper the word « spell » is taken to mean a series of at least six days in which most days occur. A spell extending into the following month is assigned to the month in which most days occur. Those spells lasting for more than 60 days are assigned to the last month which they cover it to the end.

Furthermore the frequency of completely dry months is reported in order to give an idea of the tropical dry season. These data do not correspond at all with the above mentioned dry spells, as the dry parts of successive months can total a period of 30 days without one of the months being completely dry. On the other hand dry spells > 60 days may cover completely only one month or several.

2. Annual variation of the spells.

The data of the frequency of the dry and wet spells in San Salvador are reported in the following tables 1, 2, 3, 5, subdivided into ≥ 6 , ≥ 10 , ≥ 20 and ≥ 30 days according to their duration.

The tropical « dry season » and « rainy season » are clearly distinguishable by dry and wet spells, as may be imagined.

TABLE 1. — Frequency of continuous wet spells in San Salvador 1918-47.

| Duration/Month | J | F | M | A | M | J | J | A | S | O | N | D | Year |
|----------------|---|---|---|---|---|----|----|----|----|----|---|---|------|
| ≥ 6 d | 0 | 0 | 0 | 2 | 9 | 29 | 25 | 24 | 29 | 14 | 0 | 0 | 132 |
| ≥ 10 | 0 | 0 | 0 | 0 | 2 | 9 | 5 | 7 | 8 | 7 | 0 | 0 | 38 |
| ≥ 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

The following specific results may be deduced:

a) The *continuous wet spells* with a duration of ≥ 6 days and the monthly totals of rainfall show a maximum in June and September originating in the zenital rainfalls. The frequency of the ≥ 10 day spells amounts to $1/5-1/2$ of that of spells with a duration of ≥ 6 days. In the space of time as reported in this paper, long lasting spells of ≥ 20 days do not occur even in the rainy season. The short spells of ≥ 6 days are lacking in the dry months (Tab. 1) as is to be expected.

number of days in February, but is true fact, because at the same time a spell of only 28 consecutive dry days took place in January on only 15 occasions, in March on 11 occasions (Tab. 4).

d) The *broken dry spells* show a slight falling off as compared with the continuous spells (Tab. 5). This is explained by the fact that a day of < 1 mm precipitation within a long dry spell gives rise to *two different* continuous dry spells, while still being counted as only *one broken* dry spell according to its definition.

TABLE 5. — Frequency of broken dry spells in San Salvador 1918-47.

| Duration/Month | J | F | M | A | M | J | J | A | S | O | N | D | Year |
|----------------|----|----|----|----|----|---|---|---|---|----|----|----|------|
| ≥ 6 d | 21 | 19 | 26 | 36 | 24 | 4 | 7 | 3 | 4 | 21 | 39 | 27 | 231 |
| ≥ 10 | 18 | 16 | 23 | 24 | 4 | 1 | 1 | 1 | 1 | 4 | 26 | 21 | 140 |
| ≥ 20 | 13 | 13 | 17 | 11 | 0 | 0 | 0 | 1 | 0 | 0 | 11 | 12 | 78 |
| ≥ 30 | 11 | 11 | 16 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 10 | 62 |

Table 6 shows details of the decrease in frequency and increase in duration of the continuous wet and dry spells in San Salvador.

The extremes of San Salvador may now be compared with the extremes of other climates (¹) (Tab. 7).

The tropical station of San Salvador with its recording of 212 continuous

TABLE 6. — Frequency of the lengths of continuous spells in San Salvador 1918-47.

| Duration Days | Dry Spell occasions | Wet Spell occasions | Duration Days | Dry Spell occasions | Wet Spell occasions |
|---------------|---------------------|---------------------|---------------|---------------------|---------------------|
| 6 | 236 | 132 | 22 | 73 | 0 |
| 7 | 189 | 105 | 24 | 70 | 0 |
| 8 | 169 | 74 | 26 | 68 | 0 |
| 9 | 154 | 55 | 28 | 64 | 0 |
| 10 | 141 | 38 | 30 | 62 | 0 |
| 11 | 127 | 29 | 35 | 49 | 0 |
| 12 | 119 | 26 | 40 | 41 | 0 |
| 13 | 113 | 19 | 50 | 24 | 0 |
| 14 | 107 | 11 | 60 | 15 | 0 |
| 15 | 102 | 9 | 80 | 7 | 0 |
| 16 | 97 | 8 | 100 | 3 | 0 |
| 17 | 91 | 3 | 120 | 2 | 0 |
| 18 | 86 | 2 | 150 | 1 | 0 |
| 19 | 84 | 1 | 200 | 1 | 0 |
| 20 | 80 | 0 | | | |

dry days and within a distance of only 30 km from the Pacific Ocean, is far in advance of Taschkent which has an arid steppe climate [Annual average 370 mm ⁽³⁾]. The extreme continuous wet spell of 29 days for San Salvador is below that for Tomsk with 48 days. With respect to the broken wet spells, San Salvador with its 53 days in exceeded by both Wjatka and Tomsk.

3. *Reality and origin of the extreme dry spell in San Salvador.*

The above mentioned extreme dry spell in San Salvador may be analysed as follows:

This dry spell, lasting for over half a year, commenced in San Salvador on October 5th, 1944 and ended on 4th May, 1945. The careful measurements < 0.1 mm taken on October 5th, November 18th, December 31st 1944, and May

TABLE 7. — *Extreme spells in different climates.*

| Place | Dry Spell | | Wet Spell | |
|--------------------|-----------|--------|-----------|--------|
| | contin. | broken | contin. | broken |
| | in days | | in days | |
| Potsdam | 27 | 43 | 23 | 39 |
| Wjatka | 43 | 61 | 44 | 55 |
| Tomsk | 29 | 42 | 48 | 62 |
| Taschkent | 151 | 151 | 11 | 22 |
| Wladiwostok | 89 | 108 | 21 | 25 |
| Sao Paulo | 50 | 50 | 14 | 33 |
| San Salvador | 212 | 212 | 29 | 53 |

3rd 1945 leave no room for doubt in observations. What happened? Two explanations of the phenomenon present themselves: 1) analysis of the general weather situation, and 2) analysis of the local weather observations at San Salvador.

TABLE 8. — *Number of days with predominatingly northerly and southerly surface winds in San Salvador (expressed in components). The days of purely east and west winds are indicated in parenthesis. Monthly total of precipitation and number of rain days ≥ 0.1 mm ⁽²⁾.*

| Year | March | | | | | April | | | | | May | | | | |
|------|-------|----|-------|-----|---|-------|----|-------|------|---|-----|----|-------|-------|----|
| | N | S | (E+W) | mm | d | N | S | (E+W) | mm | d | N | S | (E+W) | mm | d |
| 1944 | 15 | 9 | (7) | 5.6 | 1 | 15 | 10 | (5) | 8.5 | 1 | 16 | 8 | (7) | 163.5 | 8 |
| 1945 | 24 | 6 | (1) | . | 0 | 25 | 5 | (0) | . | 0 | 19 | 11 | (1) | 131.0 | 9 |
| 1946 | 17 | 11 | (3) | 9.5 | 1 | 6 | 24 | (0) | 38.4 | 3 | 7 | 24 | (0) | 135.4 | 13 |

General weather situation: The rainy season in San Salvador usually begins in April. The weather maps for April 1945 ⁽⁴⁾ show a remarkably high pressure for that month, occasionally amounting to 1045 mb, far to the north, i. e. between the Bermudas, Cape Hatteras and New Scotland. This situation caused easterly winds in the West Indies and the Carribean area where the winter of 1944-45 proved abnormally dry. January 1945 was the driest since 1921 ⁽⁵⁾. Less than half the normal precipitation for the period January to March 1945 fell in Cuba, the Bahamas, Turks and Caicos Islands, Haiti and the greater part of Central America. In Central America the shortage lasted over April 1945 ⁽⁵⁾. Unfortunately an analysis of the weather situation prevailing over Central America at the time was impossible owing to the all too few surface weather stations and radiosondes. Hence, an examination of the local weather observations must suffice.

Local weather observations: April 1945 was a dry month. The dry season is usually characterised by northerly winds, and such winds from this direction were observed even in April 1945 in San Salvador as shown in the table 8.

While the southerly component of the predominating surface winds in April 1944 and 1946 was greater than the northerly component, the April of 1945 was nevertheless dry and dominated by northerly winds.

The relationship between the northerly winds in San Salvador, and the general weather situation is not evident in the Historical Weather Map ⁽⁴⁾ for the above mentioned reasons.

During a northerly air current the lee effect of the mountains on the northern border of El Salvador evidently acts far to the south (~ 100 km) and disperses the rain clouds even as far as the region of San Salvador.

REFERENCES:

- ⁽¹⁾HUTTARY, J.: *Häufigkeit von trockenen und nassen Perioden in verschiedenen Klimaten*. Ber. Deutsch. Wetterdienst US-Zone Nr. 42, 77-82, 1952. — ⁽²⁾ *Anales del Observatorio Meteorologico Nacional de San Salvador* 1918-1947. — ⁽³⁾ KÖPPEN W.: *Grundriss der Klimakunde*, p. 333, Leipzig 1931. — ⁽⁴⁾ *US-Weather Bureau: Historical Weather Maps*, April 1945. — ⁽⁵⁾ MARX E. H.: *Climatolog. Data 1945 West Indies and Carribean* (US-Weather Bur.) 25, 97, 1947.

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