Rainfall in MEXICO

An Essay

BY

Romulo Escobar

Ex-Chief of the Department of Agriculture and Forestry

Mexican National Commission

Universal Exposition, St. Louis, 1904

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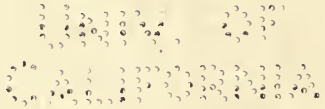

Mexican National Commission

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RAINFALL IN MEXICO

WHEN one has the opportunity of hearing the general opinion of Mexican farmers relative to the system of our rainfall, the uniformity of such opinion is somewhat astonishing, inasmuch as they all claim an unfavorable change, more and more noticeable every year, in said system, not only because of the terrible decrease of the annual precipitation, but also of the retardation and growing irregularity of the rainy season. It will not be necessary to travel extensively over the Republic to be convinced that the above mentioned belief is as general over the frontier states as it is in those of the southern portions of the country.

I have been fully convinced of the generality of such belief by means of certain interrogatories relating to the groups I have under my charge as member of the Mexican Commission to the Saint Louis World's Fair, as one of the questions put in said interrogatories, relating to the local difficulties hampering the progress of agriculture, has been answered from all parts of the Republic, stating that one of the principal difficulties is the scarcity and irregularity of rainfall, which is more and more marked every year.

And this opinion prevails not only in the Republic; an agent of the Department of Agriculture of the United States predicted for us, a few

years ago, a complete ruin on account of the decrease of our rainfall, and, Doctor Moises S. Bertoni, Director of the School of Agriculture, at Asunción, Paraguay, in speaking of rainfall in Mexico, he states that he has been able to discover a decrease, similar to the one we have suffered, over the basin of the Paraguay River, and he affirms that the same thing has happened in Argentine, Brazil, and in general, all over Latin America.

As the conclusions I may arrive at in the course of this study might be influenced, contrary to my desire, by the prejudices I may have before going into the matter, I must confess that I have never been of the opinion that the decrease of our rainfall has been so remarkable and general as it is claimed, because, in the absence of data secured by pluviometric observations, which would be the only reliable foundation we could find, I have been unable to observe so marked a change as is generally admitted.

I have noticed very brusque changes indeed, series of years of real drouth, but the same have never been permanent. I have seen that many lakes situated along the sides of the various railway lines I have been over during many years, such as the lakes Encinillas and Patos, a short distance from the line of the Mexican Central Railway, built in 1881, have for many years occupied a greatly reduced surface, and that the last mentioned lake has in some instances disappeared completely; but at other

times I have seen both lakes with as much water as they ever had since the first time I saw them. Lake Patos, for instance, only a few years ago, reached a maximum capacity never before recorded even by the oldest inhabitants of the adjacent districts. I have been unable to notice any visible change in many of the streams I have known from childhood; I have heard, however, of rivers which have entirely disappeared, but on the other hand, I have seen new ones come into existence, and whenever the former occurrence has happened, the same has been the result of the felling of forests located in the upper hydrographical slopes, or because a current of extraordinary force has swept away from creeks and ravines their alluvial deposits, thus diminishing their means to arrest the flow of rain water, which in former times used to settle in their basins, and facilitating the drainage of the same.

The belief that the railways have been instrumental in bringing about the decrease of rainfall, not because of the forests destroyed on their account, but due to the strange relations attributed to them, probably because their construction coincided with a period of decrease in our annual precipitation, has always appeared to me as unfounded, and the only reason why I mention it is because of its universality, though I consider the same unworthy of comment.

The belief which attributes such marked changes to the felling of forests does not appeal to

me as unreasonable, but I do think that its influence has been somewhat exaggerated, since I have heard such complaints not only in places where forests have been destroyed, but also in settlements far away from any line of communication that could cause an extensive felling of the forests, and because I have noticed that said changes are claimed in communities whose dominating winds during the rainy season do not come from the quadrant where the forests have been felled, and, even admitting that the above influence could be of a more local character than what would be proper to believe, it has been demonstrated that the effect claimed is caused by an extensive felling of the forests in the direction towards which the dominating winds will blow.

The opinion of the Baron of Humboldt and of the wise Agriculturist Boussignault, the distinguished travelers who visited and studied our country, cannot be disputed, as it is an established fact that the extensive destruction of the forests brings about the most lamentable results, especially so in regard to the life of spring waters in the lowlands, but I do believe that the above opinion has been accepted with increased significence as a basis to prove the decrease of our rainfall.

I am of the opinion, besides, that the question of rainfall, like many others, has been made the subject of superstition. Persons of superstitious inclinations always remember the times when their

omens have turned into reality, but they forget the many instances when they have erred. Such is the case with us, we keep fresh in our memory the years of heavier rains we have seen from childhood and in speaking of them in times of drouth we will surely come to the conclusion that our supply of rainfall has decreased. Ever since I have been able to remember, I have heard people complain of the want of rain and often have heard the statement: "This is the worst drouth we have ever experienced." On the other hand, I have never heard any comment at all in normal or good years; it seems as if the latter, being considered exceptional, does not deserve any mention.

As persons of an advanced age unanimously confirm this fact, I have been led to believe that the change in our system of rainfall would appear more marked if a long period of time would be subjected to comparison, instead of considering only the last third part of the nineteenth century.

The opening of new waterworks, canals, etc., are a more frequent cause than in the past for the exhaustion of rivers and rivulets; they hamper the facilities for irrigating the lower lands, and people who notice the decrease in the volume of water of a river, which never may have been known to become dry, or those who experience the loss of crops where they have been abundant in the past, without knowing or even considering the direct cause of such phenomena, are prone to declare that never before

have they seen such scarcity of water, and thus, the above mentioned idea assumes the proportions of a general belief.

I have gone as far as to imagine that said belief might in some way effect the question of laborers for agricultural purposes. It is a known fact that laborers are getting to be more and more scarce every day in the farming industries, not only on account of the reconcentration of the rural population in the cities and towns, but also on account of an increase of the other classes of work, developing even in the farming districts. There are many at present which have been completely abandoned, owing to the fact that many enterprises of a paying character in the past would be a dead loss at present; and because the construction of new railway lines, modern factories and the operation of new mines, take a large number of laborers away from agricultural pursuits. Farmers who generally cultivate an extensive system of lands, are at present unable to secure the number of laborers they could find in former times, they, however, insist upon planting the same area of land and even clear new plots, which they are incapable of treating as often and cultivating under the laborious rules of agriculture practiced fifteen or twenty years ago. Moreover, experience has demonstrated beyond doubt that cultivation means economy of water, that a deep preparation of the soil before planting or the treating of a field after irrigation or rain have taken

place, enables the soil to absorb a greater amount of water and to maintain the moisture it may have for a longer period of time. There is enough truth in the above to authorize the statement that the cultivation of the soil is equivalent to its irrigation. If the work of cultivating the soil is attended with many difficulties, if the same is effected in a deficient manner, the results are bound to be equal to those experienced on account of the scarcity of water.

May we not presume that the labor question, owing to the conditions mentioned, is to a certain extent responsible for the belief that our system of rainfall has enormously decreased?

Laboring under these ideas I have commenced my study, drafting diagrams showing the precipitation in each of the places where there is a meteorological observatory, and from which I have been able to secure the data corresponding to a period of not less than six years, such being the minimum time I have adopted to consider the changes that may have occurred in their system of rainfall. For localities which have furnished me with a statement of their monthly precipitation, I have drawn annual curves to the end of discovering whether there has been any delay or increase in the irregularity of their rainfall. These diagrams have been drawn by taking a line to represent the average annual precipitation admitted by me, in a period subsequent to 1877, and marking on said line the abscissas representing

the periods of time, the years and months, I have drawn those which appear above or below the line, as the case may be, to show the increase or decrease over or below the normal precipitation of each year.

I will treat the diagram of each locality separately, and I will afterwards make an abstract or recapitulation to enable me to establish deductions of a general character, in connection with which I will endeavor to set aside my personal views in the matter, bearing only upon the results shown by the recapitulation.

It is to be regretted that we have not a more extensive meteorological system, and that there are but limited observations, prior to 1877; but in spite of this fact, these studies must be carried forward with the idea that, though the data at our disposal are insufficient, and that we are in danger of erring in our deductions, and even though we may leave many blank spaces in our work, since it is impossible to do everything at one time, we will, however, accomplish one material advantage, *i. e.*, the work of compilation.

Many indeed have been the hardships attending the work of collecting what few data I have slowly gathered, though I have been honored with the kind co-operation of some disinterested managers of observatories, whose names I will mention in each case and for which I feel sincerely thankful, and I trust that my present work will save this

troublesome task to those who, possessing more knowledge and better elements, may in the future undertake a vaster study of a question which so deeply affects our country.

I have no doubt that the conclusions arising from my study may be in conflict with the individual opinion of many others, since the former will refer to a matter where most people generally follow their own beliefs, it being impossible to destroy the value of the weak or strong arguments upon which they base the same; however, I hold that no argument can logically give better support to my deductions than the proofs rendered by pluviometric records, therefore, I shall use the latter for my guidance. Moreover, the fact of the meteorological observatories being located in populated centers, will naturally show greater changes than those claimed in the rural districts, provided we admit as true that the felling of the forests has had so great influences in the matter as are attributed to it, it being proper to assume that all the observatories we have are situated in the heart of districts where the destruction of the forests has been more extensive.

Being convinced of the advantages gained by making a separate study of the changes of the precipitation of rainfall in the different zones of the Republic, as the number of observatories are limited and the same are irregularly distributed over the nation's territory, I have preferred to study the precipitation in the same order in which I made out the

diagrams without considering the geographical location of the observatories.

When mentioning the data furnished by each observatory, I will refer, by way of information, to several other data taken principally from an article published by Engineer Guillermo B. y Puga, and from a book called "Geographical and Statistical Notes on Mexico", written by Licentiate Matias Romero, in which book I have found many interesting data for this study. I have also compared many of the data mentioned herein with those contained in a small but important book called "El Clima de México", written by Mr. Manuel Moreno y Anda (see enclosure No. 1).

Yuma, Arizona, U. S. of A.

DATA

Altitude above sea level	43 m.	Puga
Average annual precipitation	78 mm.	"
Number of years recorded	28 years	"

Annual Precipitation (C. M. O.)

1878	73.1+	1890	
1879	83.6+	1891	67.8—
1880	18.8—	1892	85.1+
1881	24.9—	1893	85.6+
1882	45.2—	1894	74.9+
1883	59.7—	1895	33.8—
1884	148.8+	1896	64.8—
1885	69.1—	1897	106.2+
1886	135.9+	1898	58.7—
1887	99.1+	1899	15.2—
1888	74.9+	1900	21.6—
1889	119.1+		

Accepted average annual precipitation	71 mm. 1
Number of years	22

The above data, though taken from observations made abroad, are similar to the ones that could be obtained in the northwestern region of the State of Sonora and northeast of lower California.

The smallness of the precipitation is remarkable. In none of our observatories have we recorded such low precipitation.

From 1880 to 1883, inclusive, the curve of precipitation shows a decrease below the line representing the average annual precipitation. After 1894 the curve comes down again and there is only one year, that of 1897, which shows an increase over the average precipitation.

El Paso, Texas, U. S. of A.

DATA

Altitude above sea level	1,205 m.	Puga
Average annual precipitation	334 mm.	"
Number of years	6	"

Annual Precipitation (C. M. O.)

1879	168.4—	1889	180.3—
1880	365.0+	1890	
1881	461.5+	1891	56.4—
1882	210.1+	1892	135.1—
1883	328.2+	1893	276.3+
1884	464.8+	1894	107.7—
1885	185.7—	1895	259.1+
1886	204.7—	1896	248.7+
1887	248.7+	1897	315.2+
1888	248.7+	1898	156.5—
1889	185.4—	1900	201.9—

Accepted average annual precipitation	234 mm. 8
Number of years	21

Rainfall at El Paso, Texas, recorded during this period of time, serves the purposes of this study as data relating to the northern portion of the State of Chihuahua owing to the proximity of the latter state to the boundary line.

From 1885 to 1894 there are only two years over the average precipitation, 1888 and 1893. From 1895 there is a series of three years over the average precipitation, and from the latter date the curve shows a decrease covering the other three years. I have been unable to secure any later data to 1900, but I am of the opinion there must be an

increase, as the last two years, especially the present one, have been favorable in this respect.

The mere inspection of this diagram shows a decrease in the amount of annual rainfall.

Galveston, Texas, U. S. of A.

DATA

Altitude above sea level	12 m.	Puga
Average annual precipitation	1328 mm.	"
Number of years	13	"

Annual Precipitation (C. M. O.)

1878	1546.9+	1889	953.0—
1879	683.3—	1890	
1880	1294.6+	1891	1054.3—
1881	1353.3+	1892	629.4—
1882	1465.1+	1893	899.9—
1883	790.2—	1894	1032.3—
1884	1526.0+	1895	988.3—
1885	1589.0+	1896	602.2—
1886	977.9—	1897	742.7—
1887	1103.1—	1898	1066.8—
1888	1526.2+	1899	1060.7—
		1900	1769.4+

Accepted average annual precipitation	1120 mm. 6
Number of years	22

Data relative to Galveston can be compared with those of several points of our Mexican gulf zone.

From 1889 to 1899 the precipitation appears below the accepted average, and during that period there might be an increase only in 1890, for which year I could not secure any data.

The inspection of this diagram shows a decrease in rainfall, though at the present time the same seems to be increasing.

Zacatecas, Zacatecas, Mexico

DATA

Altitude above sea level	2496 m.	Puga
Annual average precipitation	819 mm.	"
Number of years considered	10	"
Northern latitude	22° 46′—Matias Romero	
Average barometric pressure	573 mm. 4	" "
Maximum temperature	21° 8′	" "
Minimum "	6° 1′	" "
Medium "	13° 2′	" "
Prevailing direction of the clouds	S. E.	" "
" " " " wind	S. E.	" "
Number of years	10	" "

Annual Precipitation

(J. A y Bonilla and C. M. O.)

1874	900.0+	1888	1446.8+
1875	844.0+	1889	562.9—
1876	687.0+	1890	658.6+
1877		1891	412.0—
1878	560.0—	1892	226.0—
1879	672.0+	1893	163.0—
1880	690.0+	1894	368.9—
1881	700.0+	1895	271.8—
1882	717.0+	1896	480.6—
1883	825.0+	1897	784.9+
1884	990.0+	1898	516.0—
1885	981.0+	1899	409.0—
1886	798.0+	1900	805.3+
1887	978.0+	1901	452.9—

Accepted average annual precipitation 652 mm. o
Number of years 24

The diagram for Zacatecas is one of the most interesting among all those I have prepared, because in the majority of the latter years of heavy rainfall alternate with those of low precipitation, thus causing the curve to go up and down within short distances, while in the former diagram a constant increase is shown since 1878 to 1888, the decrease from 1885 to 1887 being insignificant.

From 1889 to 1897 there is a curve beneath the average line, this latter year being, among those of the above period, the only one showing a marked increase over the normal precipitation.

After 1898 the diagram continues to show several irregularities similar to those of other localities.

Reference to the diagram will show a decrease in rainfall, though, like Galveston, there is an apparent tendency to increase.

The curves for monthly precipitation I have drawn for 1894 to 1901 demonstrate a marked irregularity, the year 1895 being remarkable owing to the low precipitation during the regular rainy season.

Guadalajara, Jalisco, Mexico

DATA

Altitude above sea level	1566 m.	Puga
Average precipitation	864 mm.	"
Number of years	6	"
Northern latitude	20° 41′	M. R.
Average barometric pressure	636 mm. 2	"
Maximum temperature	35° 5′	"
Minimum "	4° 5′	"
Medium temperature	19° 7′	"
Average annual precipitation	861 mm. 9	"
Number of years	7	"

Annual Precipitation

(M. Nieto C. M. O. and Belem Hospital)

As in the data secured from Guadalajara there are several differences. I have in some cases taken the averages between the data furnished by the Director of the Guadalajara Observatory and those secured from the C. M. O., relating to the latter as well as to the Belem Hospital Observatory.

1874	900.0—	1888	991.0—
1875	844.0—	1889	792.0 pr. 2—
1876	687.0—	1890	1076.9 " 3—
1877	830.0—	1891	1087.1 " 3—
1878	1083.0—	1892	789.7 " 2—
1879	670.0—	1893	728.9 " 2—
1880	1092.0—	1894	2003.8 " 2+
1881	1032.8 per 2—	1895	2488.6 " 2+
1882	828.0 " "	1896	1426.7 " 2+
1883	719.2 " "	1897	1340.7 " 3+

1884	605.4—	1898	1875.8 pr. 2+
1885	1143.0+	1899	1432.3 " 2+
1886	853.9	1900	
1887	1013.4—	1901	1323.9+

Accepted average aunual precipitation 1134 mm. 5
Number of years 24

The most remarkable feature of the diagram corresponding to Guadalajara is, that prior to 1894 all years show a precipitation inferior to the normal average, with the exception of 1885, which shows a slight increase, but after 1894 all years had more than the normal rainfall, a rather curious circumstance, which would at least indicate an amelioration in the system of rainfall in that city.

The inspection of the diagram demonstrates an increase of rainfall.

In the curves for monthly precipitation I have made up with data relating to years subsequent to 1889, furnished by Mr. Mariano Nieto of the State Observatory. It may be seen that the curve begins to rise in every case either in May or June, that is to say, that the rainy season begins at such time. It also shows that the rainy season is well defined. As the curve will not come down again until one of the last three months of the year, generally October, and that the month of April is one of the dryest months all through, as it only had a precipitation worthy of note, *i. e.*, 125 mm., in 1896, the same being either nothing at all or very insignificant in all other years.

Saltillo, Coahuila, Mexico

DATA

Altitude above sea level	1632 m.	Puga
Average annual precipitation	554 mm.	"
Number of years	3	"
Northern latitude	25° 25′	M. R.
Medium pressure	632 mm 1	"
Maximum temperature	34° 0′	"
Minimum "	2° 8′	"
Medium "	16° 8′	"
Average annual precipitation	527.3	"
Number of years	4	"

Annual Precipitation

(M. Kubicza, Manager of the Observatory of the College of San Juan Nepomuceno)

1885	506.5—	1894	815.5+
1886	493.6—	1895	596.0+
1887	674.4+	1896	713.0+
1888	639.9+	1897	343.0—
1889	776.0+	1898	405.0—
1890	585.6+	1899	553.8+
1891	313.0—	1900	741.5+
1892	777.9+	1901	164.3—
1893	307.4—		

Accepted average annual precipitation	553 mm. 3
Number of years	17

The only thing worthy of note that I find in Saltillo's diagram is the uniform increase of annual precipitation since 1897 until 1900, and the considerable decrease, which is the lowest one in the

period of time registered, corresponding to 1901. On the other hand, the irregularities shown in the diagram are in proportion to the precipitation and are not so remarkable as those in other observatories.

The inspection of the diagram does not seem to demonstrate either an increase or a decrease, although the last year shows a marked decrease of rainfall.

The curves for monthly precipitation show the following features: Great irregularity between one year and the others; the unsettled and variable character of the rainy season; the irregularity of precipitation in the months of July and August, in which the amount of rainfall has been sometimes very heavy, and rather insignificant in other years. If a curve be drawn to represent the normal year to compare the same by superposition with that of every year, very remarkable differences would be found in every one of the years registered.

Leon, Guanajuato, Mexico

DATA

Altitude above sea level	1798 m.	Leal	Puga
Average annual precipitation	728 mm.	"	"
Number of years	10	"	"
Northern latitude	21° 7′		M. R.
Medium barometric pressure	617.4		"
Maximum temperature	36° 6′		"
Minimum "	—1° 1′		"
Medium "	18° 9′		"
Prevailing direction of the clouds	S. W.		"
" " " winds	N. N. W.		"
Average annual precipitation	729.8		"
Number of years	14		"

Annual Precipitation and Number of Rainy Days

(Mariano Leal)

1878	601.5— 92	1890	867.2+145+
1879	709.2+100—	1891	429.8—116—
1880	825.4+119+	1892	473.2—129+
1881	629.9—127+	1893	648.5+109—
1882	699.3+117—	1894	552.7—125+
1883	900.9+134+	1895	531.3—113—
1884	613.1—111—	1896	314.6—117—
1885	786.2+130+	1897	571.7—118 normal
1886	725.9+ 97—	1898	747.6+102—
1887	781 8+136+	1899	510.3—108—
1888	869.6+152+	1900	560.6—127+
1889	767.5+134+	1901	439.5— 94—

Accepted average annual precipitation 648 mm. 2
Average number of rainy days per annum 118
Number of years 24

The diagram showing Leon's annual precipitation has the following notable features worthy of mention: First.—A series of successive years above the average precipitation, running from 1885 to 1890, inclusive. Second.—That in years prior to 1890 the majority of years recorded are above the normal line, there being only three with a lower precipitation, *i. e.*, 1878, 1881 and 1884, while after the above mentioned year (1890) almost all have had a very limited precipitation, as there is only one year with normal precipitation, 1893, and another one with a higher precipitation, 1898.

The mere inspection of this diagram demonstrates a decrease of rainfall, and the part corresponding to the later years is also descending, which fact does not occur with other diagrams I have studied.

I believe the latter diagram can be mentioned as the one which better characterizes a period of drouth shown in the last decade of several other observatories, whose data I have studied and will mention hereinafter.

In reference to the above observatory, which is one of the most important in the country, from an agricultural point of view, the data relating to the same having been furnished me by its manager, I have made up a diagram showing the number of rainy days it had since 1878, and I note that the line follows a regular course, to a certain extent, in accord with the line of precipitation in the majority

of years, although the same thing does not occur in others, such as 1881, 1893, 1894, 1896, 1898, and 1899.

The curves of monthly precipitation do not appear so irregular as they do in other observatories, but they are, however, more irregular than those for Toluca, Mexico, and Puebla. The period of rainfall represented by those curves demonstrates but few interruptions and no delay whatever in the rainy season, as it is generally seen that the curve begins to rise in the months of May or June.

In order to discover what other peculiarities or changes there may be, in the latter as well as in other diagrams, without my referring to the same, it would be necessary to make a more laborious and detailed study than the one afforded by the circumstances and the purpose of the present work.

Toluca, Mexico

DATA

Altitude above sea level	2625 m.	Puga
Average annual pecipitation	678 mm.	"
Number of years	2	"
Northern latitude	19° 17′	M. R.
Average barometric pressure, 1896	556 mm 6	"
Maximum temperature "	28° 7′	"
Minimum " "	3° 8′	"
Medium " "	13° 8′	"
Prevailing direction of the clouds, 1896	N. E.	"
" " " winds "	W. and W. S. W.	"

Annual Precipitation and Number of Rainy Days

(C. M. O. & E. Schulz)

As in some cases the data I have secured do not agree, I have noted the averages:

1883	729.9+	
1884	563.1—	
1892	662.9	average of 2—131—
1893	843.7	+160+
1894	572.8	—123—
1895	660.3	average of 2—154+
1896	618.8	—146—
1897	549.6	—123—
1898	778.5	average of 2+188+
1899	715.1	" " 2+161+
1900	733.7	+146—
1901	628.2	—143—

Accepted average annual precipitation	676 mm. 6
Average number of rainy days	147—10 years
Number of years	12

The data secured are insufficient to show, by the mere inspection of the diagram, any change in system of rainfall of this locality. The line shows a decrease in the last years.

The course of the line relating to rainy days is almost always in accord with the annual precipitation.

The curves relating to monthly precipitation show a relative regularity during the rainy season.

Mexico, Federal District

DATA

Altitude above sea level	2282 m.	C. M. O.
Average annual precepitation	582 mm.	"
Number of years	20	"
Northern latitude	19° 26′	M. R.
Medium barometric pressure	586 mm. 4	"
Maximum temperature	31° 6′	"
Minimum "	1° 7′	"
Medium "	15° 4′	"
Prevailing direction of the clouds	S. W.	"
" " " wind	N. W.	"
Number of years	15	"

Annual Precipitation (C. M. O.)

Era Prior to 1877

1841	451.7—	1869	718.3+
1842	541.3—	1870	695.0+
1843	659.6—	1871	746.4+
1844	549.0—	1872	758.7+
1845	677.0+	1873	596.2—
1865	1011.0+	1874	737.1+
1866	568.1—	1875	669.1—
1868	692.1+		

Average annual precipitation for era prior to 1877 — 671 mm. 3

Number of years — 15

Era Subsequent to 1877

1877	404.0—	1889	408.1—
1878	892.6+	1890	638.1+
1879	477.2—	1891	658.3—

1880	552.2—	1892	444.2—
1881	505.2—	1893	568.6—
1882	661.0+	1894	331.8—
1883	608.7+	1895	559.1—
1884	468.5—	1896	452.0—
1885	675.8+	1897	652.1+
1886	531.2—	1898	593.7+
1887	812.7+	1899	581.1+
1888	739.9+	1900	535.9—
		1901	527.1—

Accepted annual precipitation for previous era	571 mm. 1
Number of years	25
Average annual precipitation calculated by all data on hand	608.7
Number of years	40

The diagram for the City of Mexico, corresponding to last twenty-five years, is not of the kind which clearly demonstrates a decrease in rainfall by simply glancing over the design.

The rising and falling portions of the line alternate at short intervals.

The diagram, however, shows, like others I have prepared, a period of drouth or decrease of the curve in the form of a swing, in connection with the last part of the period registered. It is remarkable to see how the line in the last four years shows an uninterrupted decrease.

But the study of the numerical data I have referred to above, is more forcible, to my regret, than the material inspection of the diagram. In fact, the average for the era prior to 1877 is greater than the total average, and the former and the latter

are greater than the average for the era subsequent to 1877, and, this being one of the localities where the largest number of data can be obtained, I feel authorized to accept the statement that rainfall has decreased at the Capitol of the Republic.

The curves relating to monthly precipitation cannot be considered very irregular, but I do believe that remark should be made that during all the second part of the period recorded, that is, during the last twelve or thirteen years, we have not had in the City of Mexico such heavy rainfalls as those of the months of July and August of 1878, September 1880 and 1886, and July of 1887.

Puebla, Puebla, Mexico.

DATA

Altitude above sea level	2167 m.	Puga
Average annual precipitation	1185 mm.	"
Number of years	10	"
Northern latitude	19° 03′	M. R.
Average barometric pressure	593 mm. 2	"
Maximum temperature	31° 9′	"
Minimum "	1° 1′	"
Medium "	15° 7′	"
Prevailing direction of the clouds	E. N. E.	"
" " " " wind	N. E.	"
Average annual precipitation	926.0	"
Number of years	14	"

Annual Precipitation

(F. de P. Servin "State College", and G. Carrasco of the "Catholic College")

As there are two observatories in Puebla furnishing me with data, I have decided to prepare and study two separate diagrams relative to the same city, though I did not do likewise in regard to Guadalajara, in order to have an idea of the variations that may occur through observations made within short distances, and I have been really surprised at the differences discovered. I was well aware of the fact that different precipitation may be recorded in two separate wards of the same city, but when comparing the annual data I did not expect that such marked differences would ever appear as

those shown by the data mentioned hereinafter, or as may be seen from the diagrams I have prepared.

As I have noticed some differences between the data furnished me by the C. M. O. relating to the "Catholic College" at Puebla, and those provided by the manager of the latter observatory, I have caused the averages to appear.

State College

1878	1117.5+	1891	1025.3+
1879	846.3—	1892	824.2—
1880	977.7+	1893	1273.8+
1881	912.2+	1894	719.7—
1882	930.2+	1895	603.7—
1883	974.1+	1896	686.1—
1884	673.9—	1897	827.9—
1885	973.2+	1898	938.8+
1886	750.4—	1899	787.0—
1887	1193.2+	1900	763.7—
1888	984.3+	1901	737.3—
1889	790.7—		
1890	853.5—		

Accepted average annual precipitation 881 mm. 8
Number of years 24

Catholic College

1877	925.7 average—	1891	1002.4 average—
1878	1281.9 " +	1892	983.9—
1879	1016.4 " —	1893	1867.5—
1880	1568.5+	1894	757.4—
1881	932.0+	1895	644.8—
1882	1205.1 average+	1896	688.5—
1883	1498.7+	1897	973.0—
1884	1105.7—	1898	963.0—

1885	1582.2+	1899	900.8 average—
1886	902.7—	1900	869.3—
1887	1848.5 average+	1901	759.7—
1888	2263.4 " +		
1889	1070.8—		
1890	680.8 average—		

Accepted average annual precipitation 1131 mm. 1
Number of years 25

The diagram prepared with the data furnished by the "Catholic College" is by far the most irregular as compared with the one made with data from the "State College", but the following may be found in both of them: That the curve falls twice in the form of a swing during the second half of the period recorded, and that the line of the diagram continues to fall without interruption during the last four or five years.

The curves relating to monthly precipitation are a great deal more irregular in the "Catholic College" than they are in the "State College", though a general agreement is observed between them.

Pachuca, Hidalgo, Mexico

DATA

Average anuaal precipitation	242 mm.	Puga
Number of years	2	"
Altitude above sea level	2460m	M. R.
Northern latitude	20° 07′	"
Barometric pressure	574 mm. 8	"
Maximum temperature	27° 2′	"
Minimum "	0.6′	"
Medium "	13° 7′	"
Prevailing direction of the clouds	S. W.	"
" " " wind	N. E.	"
Number of years	1	"

Annual Precipitation

(A. Romero and Y. M. Cobos)

1893	475.4—	1898	2952.4+
1894	146.5—	1899	2504.3+
1895	327.2—	1900	1060.4—
1896	226.5—	1901	2006.0+
1897	2749.0+		

Accepted average annual precipitation 1383.0

Number of years 9

The diagram relating to Pachuca is the most irregular of all those I have prepared, and the discrepency from one year to the other, in regard to precipitation, is so great that one feels inclined to doubt the veracity of the above data, but fortunately, I sucured my information directly from the manager of the observatory at Pachuca, who was so kind as to furnish the same, and, besides, the said data agree with those provided by Mexico's Central Meteorological Observatory.

The curves relating to monthly precipitation are equally irregular from one year to the other, as may be understood from the fact that the months of maximum precipitation which were recorded in each year were:

1893	June	177.3
1894	April	37.1
1895	October	76.6
1896	September	89.7
1897	July	716.0
1898	September	737.7
1899	June	721.2
1900	December	679.3
1901	September	870.0

The above is really surprising since it is not observed in any other part of the Republic from where meteorological data can be obtained.

The above is sufficient in itself to form an opinion in regard to the astonishing irregularity of Pachuca's system of rainfall, which could perhaps be explained by being acquainted with the location of the city and the orographic development of the adjoining region, or through other causes which serve to establish the character of the climate.

Even in other data I have been able to obtain there is something abnormal; for instance, it appears that the prevailing direction of the clouds in one year was towards the southwest, while the prevailing direction of the wind in the same year was towards the northeast, that is, in an entirely opposite direction.

Colima, Colima, Mexico

DATA

Altitude above sea level	507 m.	Puga
Medium annual precipitation	1053 mm.	"
Number of years	12	"
Northern latitude	19° 11′	M. R.
Barometric pressure	718 mm. 3	"
Maximum temperature	37° 2′	"
Minimum "	9° 4′	"
Medium "	24° 8′	"
Prevailing direction of the clouds	S. W.	"
" " " wind	S. W.	"
Number of years	1	"

Annual Precipitation

(F. Castrejon. Observatory of the Colima Seminary and C. M. O.)

1877	755.4—	1892	892.6—
1878	1416.5+	1896	749.4—
1879	1049.9+	1897	898.7—
1880	960.4—	1898	1038.8+
1891	1223.0+	1899	1207.0+
		1901	859.1—

Accepted average annual precipitation 1004 mm. 6
Number of years 11

As there are many years missing in this series, it is impossible to point out any special feature of the diagram.

Mazatlan, Sinaloa, Mexico

DATA

Altitude above sea level	76 m.	Puga
Average annual precipitation	798 mm.	"
Number of years	20	"
Northern latitude	24° 11′	M. R.
Average barometric pressure	759 mm. 3	"
Maximum temperature	34° 1′	"
Minimum "	10° 3′	"
Medium "	25° 2′	"
Prevailing direction of the clouds	N. W.	"
" " " wind	N. W.	"
Average annual precipitation	519.2	"
Number of years	4	"

Annual Precipitation and Number of Rainy Days

(N. Gonzales)

1880	948.6+79 +	1891	390.9—67—
1881	1454.2+99 +	1892	326.1—60—
1882	425.6—92 +	1893	777.4—74—
1883	748.6—83 +	1894	560.2—62—
1884	1122.6+102+	1895	1088.5+75 equal
1885	1117.5+91 +	1896	594.2—70—
1886	799.5—74 —	1897	695.3—67—
1887	1206.4+91 +	1898	663.5 63—
1888	676.1—76 +	1899	852.1+54—
1889	834.4+77 +	1900	812.6+59—
1890	685.8—73 —	1901	948.5+71—

Accepted average annual precipitattion 805 mm. 8

Average number of rainy days 75

The diagram showing Mazatlan's annual rainfall offers many irregularities, and the same demonstrates a decrease, followed by a rise in the curve, such as has been noticed in other cities, commencing in the present case in 1887 and reaching its maximum elevation in 1895, dropping once more during the following year and again rising with slight alternate interruptions during the last five years.

The curves relating to monthly precipitation show greater irregularities than those for other cities of the Republic, such as Mexico, Toluca, and Puebla, and the same are more remarkable because there are slight interruptions during the rainy season; that is to say, that the curve rises and falls uniformly without projecting in or out. The greatest irregularities consist in the discrepancies found between the months of heaviest rains in one year and those of the other, therefore, the curve appears quite high in some years and very low in others.

In regard to the diagram referring to rainy days of each year, it is worthy of note that prior to 1889 there is not a single year showing a marked decrease below the normal line, as only the year 1886 has one rainy day less, while after 1899 all the years are inferior, with the exception of 1895, which was equal to the normal average.

The appearance of the diagram shows, in a general way, that rainfall has decreased.

Monterrey, Nuevo Leon, Mexico

DATA

Altitude above sea level	496 m.	Puga
Northern latitude	25° 40′	M. R.
Average barometric pressure	709 mm. 1	"
Maximum temperature	33° 2′	"
Minimum "	11° 7′	"
Medium "	21° 0′	"
Prevailing direction of the wind	S. E.	"
Number of years	1	"

Annual Precipitation

(A. Carrillo)

1865	744.0—	1893	137.0—
1885	427.0—	1894	489.9+
1886	417.5—	1895	549.9+
1887	449.0—	1896	628.0+
1888	341.3—	1897	581.0+
1889	283.2—	1898	488.8+
1890	338.6—	1899	969.4+
1891	264.2—	1900	795.6+
1892	186.6—	1901	729.7+

Accepted average annual precipitation 475 mm. 1
Number of years 17

The diagram showing Monterey's annual rainfall is remarkable because of its rises and falls, which follow a continuous course during long periods of time. No sudden changes are to be noticed, such as happen with diagrams of other

observatories. Another feature worthy of mention in this diagram is that it follows a course which differs from the others generally, at least in regard to years where pluviometric registers have been secured. Prior to 1883 all the years had a precipitation below the normal figures, but the reverse happened after the above mentioned date.

As may be seen the diagram demonstrates an increase in rainfall.

It is to be regretted that only seventeen years of observation can be secured from this observatory, since the latter is so important, owing to its location and on account of the features shown by the diagram prepared for years recorded.

The curves relating to monthly precipitation are interesting because of the irregularities they indicate, owing to a period of relative drouth which always interrupts the rainy season.

Mention is equally made of the low precipitation had during the months of heavy rains corresponding to the first part of the period registered.

The year 1888 is worthy of note, because what little rain it had was distributed over almost all the months of the year, November having been the month of heaviest rains, with a very limited precipitation of 27 mm. 3.

Merida, Yucatan, Mexico

DATA

Altitude above sea level	9 m.	Puga
Average annual precipitation	830 mm.	"
Number of years	2	"
Northern latitude	20° 55′	M. R.
Average barometric pressure	760 mm. 5	"
Maximum temperature	40° 5′	"
Minimum "	12° 1′	"
Medium "	25° 8′	"
Prevailing direction of the clouds	E.	"
" " " wind	N. E.	"
Number of years	1 (1896)	

Annual Precipitation and Number of Rainy Days

(Estatistical Bulletin from Yucatan)

1875	913.0—		1896	914.7+	118+
1890	864.0—		1897	875.0+	
1891	911.0+		1898	1139.9+	124+
1892	834.0—		1899	1062.5+	78—
1893	560.0—		1900	943.6+	93—
1894	957.2+	94—	1901	601.7—	65—
1895	744.0—	97+			

Accepted average annual precipitation	867 mm. 3
Average number of raing days in 7 years	95
Number of years	12

Though there are but few years recorded, the diagram shows an annual increase of rainfall similar to the one registered in other observatories during the last four to eight years, preceded by a period of years generally poor representing in the curve the descending portion already mentioned in this study.

The examination of the diagram will not demonstrate either an increase or a decrease in rainfall.

As regards monthly precipitation, and the number of rainy days of each year, for which I have prepared curves corresponding to the last seven years, there is but little to be said.

Tuxpam, Veracruz, Mexico

DATA

Average annual precipitation	1532 mm.	Puga
Number of years	5	"
Northern latitude	20° 59′	M. R.
Average barometric pressure	763 mm.	"
Average temperature	24° 5′	"
Prevailing direction of the clouds	N. W.	"
" " " wind	W.	"
Average annual precipitation	1654 mm. 3	"
Number of years	2	"

Annual Precipitation (C. M. O.)

1879	1592.5+	1885	893.0—
1881	1505.5+	1889	1716.1+
1883	1589.0+	1890	1199.1—
1884	1109.3—	1891	1839.0+

Accepted average annual precipitation	1430.4
Number of years	8

The only thing worthy of mention at Tuxpam is that it holds the third place among the list of towns in Mexico provided with a meteorological observatory, on account of its average annual precipitation.

Teziutlan, Puebla, Mexico

DATA

Altitude above sea level	1982 meters	Puga
Average annual precipitation	1531 mm.	"
Number of years	5	"

Annual Precipitation (C. M. O.)

1878	1339.2—	1882	1263.2—
1879	1927.2+	1884	1240.6—
1881	1884.2+	1888	2268.2+

Accepted average annual precipitation	1653.7
Number of years	6

Considering Teziutlan's average annual precipitation, it holds the first place among towns from which we have data covering six or more years.

Real del Monte, Hidalgo, Mexico

DATA

Annual Precipitation (C. M. O.)

1889	768.2+	1895	621.1—
1890	828.0+	1896	435.0—
1891	1023.0+	1897	779.9+
1892	853.0+	1898	917.9+
1893	156.0—	1899	689.0—
1894	565.7—	1900	955.0+

Accepted average annual precipitation 749 mm. 2
Number of years 12

The rise and fall of the curve is well defined in the diagram for Real del Monte, said curve commencing in 1891 and ending in 1898, and of which fact I have made several mentions in the course of this study, in reference to other observatories.

Tacubaya, D. F.

DATA

Altitude above sea level	2323 m.	Puga
Average annual precipitation	683 mm.	"
Number of years	10	"
Northern latitude	19° 12′	M. R.
Average barometric pressure	583 mm. 6	"
Maximum temperature	28° 6′	"
Minimum "	0° 8′	"
Medium "	15° 5′	"
Prevailing direction of the wind	N. W.	"
Average annual precipitation	668 mm. 1	
Number of years	9	

Annual Precipitation

(M. Moreno y Anda)

1884	492.6—	1892	485.7—
1885	679.6+	1893	726.8+
1886	582.9—	1894	388.5—
1887	846.5+	1895	627.8—
1888	632.2—	1896	440.3—
1889	713.2+	1897	665.4+
1890	792.5+	1898	681.1+
1891	883.0+	1899	626.8—
		1900	668.8+

Accepted average annual precipitation 643 mm. 1
Number of years 17

The diagram relative to raiñfall at Tacubaya demonstrates a decrease at first sight during the period registered, and as it is natural to suppose,

it is quite similar to that of the City of Mexico, owing to the proximity of both observatories. We fail to discover between the two diagrams mentioned such marked differences as shown between diagrams prepared with the data secured from the "Catholic" and the "State Colleges" at Puebla.

Pabellon, Aguascalientes, Mexico

DATA

Altitude above sea level	1924 m.	Puga
Average annual precipitation	506 mm.	"
Number of years	19	"
Northern latitude	22° 04′	M. R
Average barometric pressure	607 mm. 8	"
Maximum temperature	24° 0′	"
Minimum "	12° 2′	"
Medium "	18° 2′	"
Prevailing direction of the clouds	S. S. E.	"
" " " wind	W. S. W.	"
Average annual precipitation	537 mm. 0	
Number of years	10	

Annual Precipitation (C. M. O.)

1877	337.4—	1884	262.1—
1878	467.1—	1885	648.5+
1879	434.4—	1886	539.2+
1880	697.4+	1887	669.1+
1881	602.1+	1888	758.9+
1882	444.2—	1889	566.6+
1883	605.5+	1890	344.0—

Accepted average annual precipitation	529.7
Number of years	14

The above diagram shows an increase of rainfall during the period recorded, although on a very limited scale.

Huejutla, Hidalgo, Mexico

DATA

Altitude above sea level	376 m.	Puga
Average annual precipitation	466 mm. (?)	"
Number of years	4	
Northern latitude	21° 41′	M. R.
Average barometric pressure	765 mm. 1	"
Maximum temperature	34° 0′	"
Minimum "	10° 0′	"
Medium "	23° 0′	"
Number of years	1	"

Annual Precipitation (C. M. O.)

1882	1154.6—	1886	1165.2—
1883	1215.0—	1889	2109.3+
1884	1247.2—	1890	1121.8—
1885	1093.7—	1891	1383.3+

Accepted average annual precipitation 1311 mm. 2
Number of years 8

San Luis Potosi, San Luis Potosi, Mexico

DATA

Altitude above sea level	1890 m.	Puga
Average annual precipitation	398 mm.	"
Number of years	10	"
Northern latitude	22° 09′	M. R
Average barometric pressure	613.4	"
Maximum temperature	33° 9′	"
Minimum "	1° 8′	"
Medium "	17° 4′	"
Prevailing direction of the clouds	W.	"
" " " wind	E.	"
Average annual precipitation	389 mm. o	
Number of years	9	

Annual Precipitation

(San Luis Institute and C. M. O.)

1878	432.4+	1890	531.2+
1879	380.2 av. 2+	1891	257.6 av. 2—
1880	359.2+	1892	244.5 " 2—
1881	444.0+	1893	414.1 " 2+
1882	347.5—	1894	229.1—
1883	404.0+	1895	285.7—
1884	189.9—	1896	249.7 av. 2
1885	484.0+	1897	367.8+
1886	403.3+	1898	383.5+
1887	506.8+	1899	200.1—
1888	504.8 av. 2+	1900	264.0—
1889	331.0 " 2—		

Accepted average annual precipitation 357.1 mm.
Number of years 23

The diagram relating to rainfall at San Luis could not be classified as one of the most irregular, since it does not, like in many other cities of small precipitation, depart very much from the average line of rainfall.

The examination of the diagram will show a decrease of rainfall during the latter part of the period recorded, as subsequent to 1890 all years appear below the normal line with the exception of three of them, 1893, 1897, and 1898.

Tepic, Tepic, Mexico

DATA

Altitude above sea level 1051 m. C. M. O. Puga
Average annual precipitation 1090 mm.
Number of years 7

Annual Precipitation (C. M. O.)

Era Prior to 1877

1844	1270.0—	1854	1651.0+
1845	1066.8—	1855	1231.9—
1846	1524.0+	1856	774.7—
1847	1765.3+	1857	609.6—
1848	1727.7+	1858	952.5—
1849	1955.8+	1859	1854.2+
1850	1892.3+	1866	1498.6+
1851	1638.3+	1867	1384.3—
1852	1447.8+	1868	1663.7+
1853	1333.5+		

Average annual precipitation for era prior to 1877 1433.7 mm.
Number of years 19

Era Subsequent to 1877

1885	1447.8+	1890	1409.7+
1886	1155.7—	1891	1371.6—
1887	1473.2+	1892	1231.6—
1888	1676.4+	1893	1600.2+
1889	1244.6—	1894	1181.1—

Accepted average annual precipitation, era subsequent to 1877 1379.1 mm.
Number of years 10
Average annual precipitation, figured out with all data at hand 1414.8 mm.
Number of years 29

Oaxaca, Oaxaca, Mexico

DATA

Altitude above sea level	1546 m.	Puga
Average annual precipitation	715 mm.	"
Number of years	3	
Northern latitude	17° 04′	M. R.
Average barometric pressure	636.6 mm.	"
Maximum temperature	32° 9′	"
Minimum "	6° 2′	"
Medium "	20° 6′	"
Prevailing direction of the wind	W.	"

Annual Precipitation (C. M. O.)

1878	578.0—	1890	714.4—
1879	951.0+	1891	1032.4+
1880	617.1—	1892	849.2+
1883	858.9+	1893	1098.1+
1884	516.5—	1894	663.7—
1885	550.6—	1895	713.3—
1886	940.9+	1896	700.2—
1887	1080.7+	1897	843.9+
1888	1161.0+	1898	880.5+
1889	729.3—		

Accepted average annual precipitation 814.7 mm.
Number of years 19

The diagram relating to rainfall in Oaxaca shows a fall in the curve subsequent to 1893, the same as is noticed in the diagrams for other places I have prepared, but in a general way it does not indicate a decrease in rainfall, because prior to 1886 there are similar and even greater decreases in this place, the four years of minimum precipitation recorded appearing prior to the above mentioned date.

Morelia, Michoacan, Mexico

DATA

Altitude above sea level	1940 m.	Moreno
Average annual precipitation	728 mm.	"
Number of years	2	"
Northern latitude	19° 42′	M. R.
Average barometric pressure	608.8 mm.	"
Maximum temperature	31° 5′	"
Minimum "	1° 5′	"
Medium "	16° 8′	"
Prevailing direction of the clouds	W.	"
" " " wind	S. S. W.	"
Year	1896	

Annual Precipitation (C. M. O.)

1882	648.8—	1898	707.9+
1894	527.6+	1899	772.6+
1895	837.2+	1900	626.7—
1896	619.9—	1901	831.1+
1897	580.3—		

Accepted average annual precipitation	683.5
Number of years	9

Jalapa, Veracruz, Mexico

DATA

Altitude above sea level	1321 m.	Moreno
Average annual precipitation	1540 mm.	"
Number of years	2	
Northern latitude	19° 31′	M. R.
Average barometric pressure	649.3 mm.	"
Maximum temperature	33° 5′	"
Minimum "	5° 6′	"
Medium "	18° 5′	"
Prevailing direction of the wind	N.	"
Year	1896	"

Annual Precipitation (C. M. O.)

1894	917.5—	1898	2156.1+
1895	1306.0—	1899	1670.7+
1896	1779.4+	1900	1611.1+
1897	1193.3—		

Accepted average annual precipitation	1519.2
Number of years	7

By examining Jalapa's diagram an increase of rainfall will be discovered, but this indication is of a very limited value owing to the fact that only a few years have been registered.

Guanajuato, Guanajuato, Mexico

DATA

Altitude above sea level	2060 m.	Puga
Average annual precipitation	859 mm.	"
Number of years	6	"
Northern latitude	21° 01′	M. R.
Average barometric pressure	601.3 mm.	"
Maximum temperature	30° 7′	"
Minimum "	1° 3′	"
Medium "	17° 6′	"
Average annual precipitation	964.5 mm	"
Number of years	5	"

Annual Precipitation (C. M. O.)

1881	893.5+	1892	452.0—
1883	945.2+	1893	532.5—
1884	503.8—	1894	546.0—
1885	1070.7+	1895	578.2—
1886	756.1+	1896	524.2—
1887	987.7+	1897	639.5—
1888	789.2+	1898	798.4+
1889	640.5—	1899	631.3+
1890	601.1—	1900	651.1+
1891	590.2—		

Accepted average annual precipitation	691.1
Number of years	19

I believe that none of the diagrams I have prepared is more interesting than that of Guanajuato, the same being the one that shows the curve in the form ofa swing and spread out wider, as it begins

to fall in 1887 and rises about 1900; that is to say, it covers a period of fourteen years, an incident which does not occur in any of the other diagrams. Such a long lapse of time in which the amount of rainfall begins first by decreasing and then by rising without interruption, is not shown by any of the other diagrams I have prepared.

Aguascalientes, Aguascalientes, Mexico

DATA

Altitude above sea level	1861 m.	Puga
Average annual precipitation	591 mm.	"
Number of years	6	"
Northern latitude	21° 53′	"
Average barometric pressure	605.1 mm.	"
Maximum temperature	29° 5′	"
Minimum "	2° 8′	"
Medium "	18° 6′	"

Annual Precipitation (C. M. O.)

1879	418.4—	1885	762.4+
1882	675.0+	1886	594.5+
1883	529.6—	1889	542.2—
1834	474.3—		

Accepted average annual precipitation	570.9
Number of years	7

Linares, Nuevo Leon, Mexico

DATA

Altitude above sea level	362 m.
Minimum temperature in six years	9° in February, 11 to 14, 1899
Medium temperature in six years	22° 4′
Number of years	6

Annual Precipitation and Number of Rainy Days

(Martin Stecker)

1896	796—56	1899	789—49
1897	887+60	1900	990+66
1898	543—51	1901	1014+53

Accepted annual precipitation	836 mm.
Number of years used in calculation	6

The examination of the above diagram does not permit us to appreciate whether there has been any increase or decrease of annual rainfall at Linares, because of the limited number of years observed.

Three of the years recorded appear over and three under the normal line.

In the curves relating to monthly precipitation, which I have also prepared with the data kindly furnished me by Mr. Stecker, it appears that the precipitation is heavier during two portions of the year, which fact does not happen in other localities.

The curves comprise two ascending parts, pretty well marked in the years 1896, 1897, 1899, and 1901. There are one or several months of heavy precipitation missing for 1898 in order to determine the first rise of the curve, and during 1900 the second rise was not so well characterized.

Zapotlan, Jalisco, Mexico

DATA

Altitude above sea level	1530 m.	Moreno-Puga
Northern latitude	19° 36′	M. R.
Average barometric pressure	636.8 mm.	"
Maximum temperature	36° 9′	"
Minimum "	6° 0′	"
Medium "	20° 5′	"
Prevailing direction of the clouds	N. E.	"
" " " wind	S. E.	"
Number of years	1 (1896)	"

Annual Precipitation (C. M. O.)

(S. Diaz)

1894	663.0—	1898	1027.7+
1895	836.3—	1899	963.5+
1896	915.9+	1900	1008.1+
1897	886.5—	1901	1001.8+

Accepted average annual precipitation	912.8
Number of years used in calculation	8

The examination of the diagram shows an increase in rainfall during the years recorded and the slight decreases that appear therein, the curve never falls to the point equal to that of the precipitation of the previous year in each case.

In the first period of four years there is only one year, 1896, that exceeds the normal line a little, the other three being below the latter. In the second period of four years the whole four had a precipitation higher than the accepted average.

The curves relating to monthly precipitation, during the years recorded, show a regular condition during the rainy season, rainfall being fairly well distributed, as starting in April and continuing through May and June, the curve keeps on rising and it does not drop down until November or December of each year.

Queretaro, Queretaro, Mexico

DATA

Altitude above sea level	1850 m.	Puga
Annual precipitation	569 mm.	"
Number of years	17	
Northern latitude	20° 35′	M. R.
Average barometric pressure	613.8 mm.	"
Maximum temperature	33° 1′	"
Minimum "		
Medium "	18° 1′	"
Prevailing direction of the wind	E.	"
Number of years	3	"

Annual Precipitation (C. M. O.)

1877	577.1+	1890	539.9+
1878	675.1+	1891	471.1—
1879	562.9+	1892	374.7—
1880	638.5+	1893	641.1+
1881	665.6+	1894	372.2—
1882	480.0—	1895	252.7—
1883	577.8+	1896	290.0—
1884	295.4—	1897	518.6+
1885	631.8+	1898	509.1+
1886	606.7+	1899	563.7+
1887	500.0+	1900	338.2—
1888	480.0—	1901	214.4—
1889	440.9—		

Accepted average annual precipitation	489.1 mm.
Number of years used in calculation	25

The examination of the diagram corresponding to Queretaro clearly indicates that there has been a decrease in rainfall in that city, and it shows the period of drouth appearing in other diagrams prepared by me, with a considerable fall of the curve, in the shape of a swing, corresponding to the last period of five years.

The only complete data relating to monthly precipitation that I have been able to secure are those from 1893 up to date, and from the examination of the proper curves I have drawn, it can be seen that there is no uniformity between the curves covering several years.

Hacienda del Carmen, Guemez, Tamaulipas, Mexico

Annual Precipitation

(Francisco Benitez Leal, C. E.)

1897	866+	1900	373—
1898	827+	1901	823+
1899	535—		

Accepted average annual precipitation 684.8 mm.
Number of years 5.

Although there are only five years of observation at the latter place, the proper data having been furnished to me through the kindness of Mr. Benitez Leal, I have endeavored to prepare the corresponding diagram, and I will take into account, in the general study I am preparing, the course of precipitation at Guemez, feeling really thankful that I was able to secure the necessary data, as it is the only point within the State of Tamaulipas wherefrom I succeeded in getting the desired information.

The diagram shows a decrease from the first year recorded until we get to the one next to the last, but an increase in the precipitation takes place immediately after such period, which places the line in the extreme almost as high as the starting point.

The curves relating to monthly precipitation are very irregular, and there is not a single special feature about them that would make them worthy of notice.

I have made use of the data I was able to obtain, believing that they comprise the greater part of information that could be utilized in a study of this nature. I have prepared the diagrams of annual precipitation for each of the localities where there are meteorological observatories, and the curves relating to monthly rainfall for such points as I have succeeded in securing the necessary data, and I have made notations pointing out the peculiarities I have considered worthy of mention when preparing the former as well as the latter.

I will now proceed to make a recapitulation of the latter data to the end of discovering whether they will serve to decide the following questions:

First. What has been the change in the rainfall system of the country?

Second. The change that may have occurred, has it been permanent during the last quarter of the nineteenth century, or has it been more marked at certain epochs?

Third. Has the change been general all over the country, and what may have been the cause of such change?

Fourth. What may we expect in the future?

Fifth. What can we do to remedy the evil?

See Enclosure No. 2. (A synoptical chart of pluviometric observations).

Study of the Chart

In the first column appear the names of the localities from where I have been able to secure pluviometric reports.

In the second column appear the periods of years for which I have pluviometric reports and the names of the persons who were so kind as to furnish me with them, the majority of said persons being the managers of the respective observatories. The abbreviation, C. M. O., means that the data have been secured from the Central Meteorological Observatory of Mexico, which institution published some time ago a pamphlet containing some of the data in question, the same having been corrected at a later date.

Column three shows the averages I have accepted, calculated from the greatest possible number of years, subsequent to 1877, relating to amount of annual rainfall had at the corresponding localities.

These figures indicate in the diagram of precipitation the value of the horizontal line to which I have subjected the elevations of annual rainfall.

Column four denotes the number of years upon which the above averages were calculated, to the end that the correctness of each may be appreciated.

Columns five and six denote, respectively, the maximums and minimums of annual precipitation during the whole period recorded, and the years corresponding to each column.

Column seven indicates the separation between the maximum and minimum annual precipitation. The latter difference is remarkable in regard to several observatories, and the same clearly demonstrates the irregularities of our rainfall, but I do not believe that this is an exceptional feature of our climate, as some people contend, as similar and even greater differences are recorded in other countries.

My intention, in preparing columns five and six, was to study whether any relation could exis- between the succession of years of maximum and minimum precipitation, with the increase and decrease of the average amount of rain falling annually at each place; but I have failed to discover any relation whatever, since in sixteen cases the year of heavier rainfall comes before the year of less precipitation, and in seventeen cases the matter appears to be the other way. The difference, therefore, would not justify any deduction.

In order to investigate whether there is any tendency in our rainfall to decrease or increase, if we had in all our observatories the pluviometric records for the same period of time, all we would have to do would be to divide such periods in two epochs, and compare the average precipitations calculated for each epoch; but we are not in condition to do that, because only a few observatories have any registers prior to 1877; there are some which were in operation during a certain period of years but do not exist at present; others were established lately and con-

tinue to make pluviometric observations, and there are many which did work continually.

As it has been my desire to base my conclusions upon the greatest possible number of years recorded, and have tried to avail myself of all of the few elements to be depended upon, what I have done is, to divide the era that has been recorded in each case in two periods, first and second, for which I have calculated separately the proper average precipitation, entering the same in columns eight and nine.

When the total number of years recorded is an odd number, I have not taken into consideration the precipitation of the middle year of the series, to the end of avoiding comparison between averages calculated with a different number of years, although I am convinced that the results would not have been altered in none of the sixteen cases of an odd series of years.

In column ten I denote by means of the marks of plus and minus whether there has been any increase or decrease in the average precipitation of each period, and the result thus obtained is, to my regret, quite eloquent, there being twenty-one minus signs against twelve plus marks.

We could argue against the foundation of the above conclusion that the first and second periods, in the different cases, do not refer to the same era, that is to say, that the same years are not contained in all of the latter, because, speaking about the City

of Mexico, for instance, the first period runs from 1877 to 1888, while when referring to Linares it runs from 1886 to 1898; but I believe such argument could be destroyed by the sole idea that the object of the comparison, condensed in column ten, is to find out only whether there has been any general tendency towards a decrease or increase of rainfall.

The results of such comparison, for the era I have studied, would attain the greatest possible value if all the observatories could furnish pluviometric reports from 1877 to 1901, but, unfortunately, this is not so. After this consideration, the results of such comparison would be of the greatest possible value if there was an equal number of observatories, where observations had been made at the commencement of the period of twenty-five years, and which afterwards discontinued the same, to the number of observatories established during the second period of the above mentioned era. This, also, is not the case. The majority of the observatories have been recently established, and this would give greatest weight to the argument above referred to.

Now, then, what influence could such cause of error have in the results shown by column ten?

As may be seen afterwards (column twenty-three) the tendency to an increase of rainfall during the last period of five years, in relation to the preceding period, is very remarkable, and for that reason the influence of such cause of error would

serve to *increase the plus marks in column ten*, because seven out of the twelve plus marks appearing in the latter column refer to registers carried during less than ten years in the two last periods of five years each, therefore, the plus would perhaps become minus marks if the observation had reference to another era. The error that might have been committed in speaking of the whole era of 1877 to 1901, with the data on hand, is, therefore that of obtaining a lesser difference than the real one, between the less and plus marks, and while this may be so, the above mentioned objection is superseded and the conclusion appears well founded.

In columns eleven and twelve I have marked the number of years under the normal precipitation of the whole era, as had in the first and second periods, for each observatory, and the result of the comparison corroborates the figures of column ten, since in the second periods there have been 137 years under normal conditions against 115 had in the first periods.

Right afterwards I have divided the total era under consideration in five periods of five years each; I have calculated the averages of precipitation in each one of them, showing the number of years taken as a basis of calculation, to the end of discovering their correctness as an average; I have prepared a column for data prior to 1877, and the comparison between the various columns, from numbers thirteen to twenty-five, enables us to study if

the tendencies of rainfall towards increasing or decreasing have been more apparent at any given epochs.

Recapitulation

First. There has been a decrease of rainfall in Mexico during the last twenty-five years. (Columns ten, eleven and twelve of the Chart).

This statement, which, in the opinion of many persons who believed in the decrease, may appear as a fact which does not require corroboration, since it was well known, should, however, be considered by our farmers not as a source of despair, but, on the contrary, as an encouragement to improve agricultural systems, to prevent the reckless felling of forests, and to reduce the burden of live stock from grazing lands; to promote all kinds of works that will cause the soil to absorb a greater amount of rain water, and to make provision for the collection of such water, as well as that from creeks and rivers. The above statement should also impress the idea upon the mind of our authorities that the latter works and improvements ought to be encouraged as much as possible, it being a matter of vital necessity to do so, as any efforts made at an early date will facilitate the work and enhance its usefulness.

Second. The decrease in rainfall has not been so general as has been claimed, nor even regular during the period from 1877 to 1901. Pluviometric registers, during the years recorded, show an increase in Zapotlan, Linares, Aguascalientes, Jalapa, Morelia, Oaxaca, Huejutla, Pabellón, Mérida, Monterrey, Pachuca, and Guadalajara.

Between the first five years (1877 to 1881) and the second five years (1882 to 1886) we dare say there was an insignificant decrease (column 17: 11–8+). From the second five years (1882 to 1886) to the third five years (1887 to 1891) there occurred an increase also insignificant (column 19: 10–13+). From the third period (1887 to 1891) to the fourth period (1892 to 1896) there was a general decrease in the rainfall (column 21: 18–4+).

From the fourth period (1892 to 1896) to the fifth and last period (1897 to 1901) there was a very remarkable general increase in our rainfall (column 23: 4–22+).

The results shown in columns twenty-one and twenty-three confirm the majority of the remarks I made while preparing the diagram of precipitation. The above mentioned decrease subsequent to 1891 and increase after 1896, is but the result of the falls in the form of a swing I remarked in making up the diagram, which falls, though failing to coincide in the same years in the different localities mentioned, do appear wtth some frequency in the latter part of many of the lines of precipitation.

Third. The cause of the decrease of rainfall during the period studied must have been foreign to the action of men, because, should the cause be one of those generally claimed (development of railway system, felling of the forests) the effects would have increased and would have become more noticeable in proportion to the causes originating the same.

We never before had as many railroads or destroyed as many forests as we have in the last five years, and, notwithstanding that, the latter period, as compared with the one preceding it, shows an increase of rainfall in twenty-two cases out of four where there has been a decrease.

The falling of our forests may have some influence in modifying our climate, and perhaps the change will be more marked in the future than it has been in the past, but it is not the principal cause of the changes claimed by public opinion.

The injurious influences from the reckless felling of the forests have been more instrumental in causing the disappearance of springs, especially in the mountain districts, than in the modification of our system of rainfall.

The magnitude and universality of the decrease attributed to our rainfall, and the increase of its irregularity, have been exaggerated in the public mind, there being three general causes which principally affect the case: The greater facility one has to remember and appreciate exceptionally bad years than to remember and appreciate those which happen to be exceptionally good; the opening of new waterworks required by an increase of cultivation of irrigated land in preference to those depending on rainfall, and the scarcity of manual labor for agricultural purposes (first part of this study).

The increase of rainfall in the last period of five years (column 23) is really encouraging, and it

would be more so if we did not have to record the general result shown by column ten, and so stated in the first part of the recapitulation.

There has been, lately, some tendency of increase in our rainfall, some localities have had in the last years rains which surpass the amount calculated as normal, but we have not sufficient data to support a general prediction.

There are a few cities, as may be seen from the diagrams I have prepared, whose lines of precipitation rise during one, two or three years, but only to come down again during similar lapse of time. I believe that in such places, considering the character of the curve, bad years are to occur after a series of two or three years of heavy precipitation, as they generally alternate one another in series of short duration.

There are other localities where great falls of the line precipitation occur, during a long series of years, as has been noted in the proper diagrams. In such places the continuance of a series of years slightly over the normal elevation, or any indication to drop in the curve of precipitation must be a cause of alarm, while the contrary must be received with marks of gratification and confidence. It is the widely repeated prophecy of Joseph on account of the dreams of the King of Egypt.

Fifth. In order to provide for our future in this respect, whatever the same might be, we should endeavor to unite the efforts of administrative action with those of private individuals and farmers.

Confining myself to the latter point, recommendation should be made in the first place to create partial pools and jetties to control the drainage of rainfall and thus increase the absorption of the latter; the construction of all classes of works for the purpose of collecting water should be encouraged; a sensible proportion between the number of live stock and the surface of grazing lands should be maintained; we should make a study of and endeavor to diffuse our useful wild plants, which are, without doubt, the ones which can better prosper under the conditions of our climate and soil; we ought to better the elements of our natural prairies; to build watering places for stock in the respective farms in order that the former may not have to travel long distances in search of food, destroying pastures where the soil is more or less sandy, and forming footpaths which turn in creeks and facilitate the drainage of rain water; a sensible felling of the forests and the use of improved methods of cultivating will help to bring about an economy of water.

If man has not been given the power to modify, so far, the climate, causing the increase of rainfall, he can, at least, make better use of the small quantity of water at his disposal and help nature imitating it, to the end that rainwater may be absorbed, retained, evaporated, and utilized upon the soil instead of letting it run into the sea.